Recommendations Report of the

INNOVATIVE AND INCENTIVE BASED POLICIES WORKGROUP

of the

Mobile Sources Technical Review Advisory Subcommittee

May 5, 1999

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0.0 Executive Summary

The Innovative and Incentive Based Policies Workgroup of the Mobile Sources Technical Review Subcommittee (MSTRS) was formed to make recommendations to the EPA about how to better incorporate innovative and incentive based policies into mobile source emission regulations. The Workgroup examined both changes in the regulatory process that would promote the use of more effective policies, and reviewed alternatives to current policies that would be likely to reduce vehicle emissions in more cost-effective ways. Although the range of possible policies the Workgroup could have considered was huge, the consensus was to limit the scope of its investigation to those issues that had emerged as critical in discussions of the In-Use Deterioration Workgroup and that were not being dealt with in another FACA Subcommittee (see main body of Report below for details). The major areas of focus that emerged were: how can incentives be improved to make I/M or other in-use emission programs more cost-effective?; what is the best regulatory program that provides drivers with the right incentives to allow OBD to cost-effectively replace traditional I/M in the future?; and what types of information about vehicle emissions can be provided to drivers, mechanics and States that will motivate changes in perceptions or behavior that may lead to lower emissions?

The Workgroup limited the scope of its review of policies and aspects of the policy process to those over which the EPA has jurisdiction. As we discussed particular policy options that involved the use of fees, for example, Workgroup members pointed out that it would be State or local governments and legislatures that decide about the merits or use of such instruments. The EPA role is in how those policies can "count" toward regulatory compliance. Hence, the regulatory process became focus of Workgroup attention.

The Workgroup attempted to examine the broad incentives offered by existing policies, and to consider alternative methods that provide more direct incentives to drivers, mechanics, manufacturers or State agencies to reduce emissions. Incentive policies were considered broadly to include not just direct monetary incentives like fees or scrap offers, but also policies that affect costs more indirectly or those that offer non-monetary incentives. An important example of non-monetary incentives that became an important focal point for the Workgroup is in the way the EPA grants emissions reduction credits in State I/M programs. Under the existing procedures, States have no incentive to evaluate their I/M programs or find more effective ways to reduce emissions. The Workgroup considered ways the regulatory process could be revised to provide better incentives to States. The first two recommendations below come from those deliberations.

The Workgroup's Recommendations on incentive-based policies are consistent with the direction of regulatory changes suggested by a number of EPA initiatives over the past few years. The 1995 Report on Reinventing Environmental Regulation recommends looking in new ways at regulation and the regulatory process with the goal of improving environmental quality at lower cost. The Reinvention Report suggests that this can be done by "better targeting of regulatory efforts to where the need is the greatest," and "a shift in emphasis from prescribing methods of compliance to specifying desired outcomes." It states that environmental regulations should be "performance based," allowing flexibility to meet goals while requiring accountability. Incentive policies, broadly defined, are also supposed to play an important role in new policy directions.

The EPA is currently revising its rules on Economic Incentive Programs (EIPs), which focus primarily on emissions trading and financial mechanisms, but which also include public information as a major policy category. Although the Workgroup did not do much with pure financial mechanisms, there was a good deal of work examining possible sources of information and policies for disseminating information about emissions of both used and new vehicles. These are in Recommendations 3 and 7 below.

We hope these Recommendations will help in the on-going process of improving mobile source regulations. The full Report details the Workgroup process and contains supporting arguments for each of the recommendations that follow.

I/M Recommendations

As the Workgroup began to look at State and local use of innovative and incentive-based policies, it became apparent that a major obstacle to their use is the way emission reduction credits are granted using the MOBILE emission factor model. States obtain credits for their I/M programs by running the MOBILE Model, but that Model does not provide a realistic, validated measure of the actual emission reductions being achieved by their particular I/M program. Further, the "performance standard" to which States enhanced I/M programs have to be compared has also not been adequately benchmarked to real world data. As a result, States do not have any way of evaluating the benefits of incentive measures added to current regulatory programs since these benefits are often already "taken" in the modeled credits. The first two recommendations below deal with improving the assessment of existing I/M programs by utilizing more real-world benchmarking and evaluation of these programs. These improvements are a necessary prerequisite for creating an environment that encourages the use of innovative and market-based incentives in I/M programs.

1. Recommendation that the I/M component of the MOBILE model be modified to more closely reflect real-world performance of State I/M programs

In order to allow States to determine the cost-effectiveness of various types of I/M programs and to allow the comparison of I/M with other policies to reduce vehicle emissions, including innovative and incentive-based policies, it is essential that the emissions forecasts of the MOBILE Model be as accurate as possible.

i) The Model should be made to more closely reflect the performance of existing I/M programs by drawing on evidence from on-going programs. The "performance standard" for Enhanced I/M should be examined to determine if it reflects what it is feasible for I/M programs to achieve.

For running the Model, States should be required to input local parameters, and should not be allowed to use default values for key Model parameters such as fleet mix, compliance, etc.

ii) The I/M component of the MOBILE Model should also be modified to make critical assumptions within the Model (e.g., repair effectiveness and emissions changes resulting from non-compliance and other imbedded assumptions) more clear to States. States should be encouraged to compare evidence from their programs to what is being assumed in the Model. If States implement policies that improve some aspect of their I/M program, they should be allowed to change parameters to reflect those changes in the Model runs.

iii) The EPA should develop more complete guidance for States on how to define and estimate I/M non-compliance rates, which are an input to the I/M component of the MOBILE Model. As part of this guidance, EPA should require States to determine if all failing vehicles have completed the program, and if they have not, to reflect that fact in the compliance rate used in running the Model. Then, the EPA should work with the States to develop ways of estimating, through such methods as license plate identification or DMV records, how many of the failing vehicles that have not been repaired are still being driven in the I/M region.

2. Recommendation that EPA require States to perform *ex post* evaluations of the effectiveness of I/M programs, in order for States to claim emission reduction credits from these programs

Real world evaluation is essential for allowing comparisons among policies for achieving real and cost-effective emission reductions. It is also important for determining the accuracy of the MOBILE Model forecasts for SIP credits and to allow comparisons across States with different programs.

EPA initiated an evaluation process for enhanced I/M programs as part of the original Enhanced I/M rule in 1992, but because of delays in program implementation, the first quantitative evaluations are not due for many States until the year 2000 or later. The EPA is in the process of developing methods States can use to evaluate I/M programs for this review. The Workgroup commends this effort. However, the Workgroup would like to see three additions to the current evaluation policy.

i) Evaluations should be required for all I/M programs, not just for Enhanced I/M for the same reasons discussed above.

ii) The EPA should ensure that evaluations performed as part of the I/M rule be used to confirm emission reductions contained in the SIP as forecast by the MOBILE Model.

iii) Evaluation protocols should be developed that include both in-program data and out-of-program on-road data. In-program data will allow States to evaluate I/M programs based on vehicles that get tested, repaired, and retested. It does not reveal much about that part of the fleet that does not get tested, or about avoidance of the program. Using both in-program and out-of-program data will also allow

States to identify the proportion of the fleet emissions that are part of I/M and to observe changes in that share over time. Currently, States assume a share of the fleet that participates in I/M, but that share is often not confirmed. Protocols would have to be developed for random sampling of vehicles in the I/M program, for how to measure emission reductions, and for location and timing of remote sensing/cameras or random roadside pullovers for out-of-program data.

3. Recommendations on the evidence and use of vehicle emissions information from I/M data

These recommendations deal with information about emissions by vintage, make, model and engine size from I/M data. Analysis of in-use emissions data from large numbers of vehicles, measured either in State I/M programs or by remote sensing, indicates that there is wide variation in failure rates and average emissions by vehicle model (see Appendix E for details). The Workgroup heard from the Colorado I/M program which already has a "Green Card" program which provides consumers with a rating of I/M failure rates and average repair costs by vehicle model. The Workgroup wanted to consider first whether data across different I/M programs provides consistent evidence, and second, how such data can best be used to inform drivers, mechanics, and State policy-makers.

Recommendation on I/M Test Data

EPA should require States to be prepared to provide raw I/M test result data to EPA on demand that would allow the EPA to assess the consistency and validity of the evidence on emissions and failure rates by make, model, engine size, and vintage. EPA should provide guidelines to States on the format and variables to be included on data submissions to EPA. The data submitted to EPA should be made available for analysis by other researchers.

Recommendation on analysis of I/M Program Data

EPA should continue to analyze State I/M program failure rates and average emissions by model year, make, model, engine size, and, to the extent possible, fuel delivery system. The data should be analyzed to determine if there is consistency in failure rates and average emissions by model across different State I/M programs. The analysis should consider differences in State I/M programs, such as type of emissions tests, cut points, use of fast-pass or fast-fail algorithms, etc., as well as regional differences that may affect emissions, such as average temperatures, fuel composition, and altitude. Interested parties should be allowed a period to review the analysis and provide comments to EPA.

If I/M test results by model are consistent across State programs, EPA should consider distributing the data to several audiences, for different uses:

i) internally and to CARB, to be used to identify vehicle models for more detailed in-use emissions compliance testing; this may result in better use of limited compliance testing resources;

ii) to States, to be used to update high- and low-emitter profiles used to require more frequent I/M testing of likely high-emitting vehicles or to excuse likely low-emitting vehicles from I/M testing; this may result in more cost-effective I/M programs;

iii) to States, vehicle manufacturers and dealers, and repair facilities, to be used to identify vehicle models with common emissions problems and repairs, as well as false failures due to details of the I/M program (e.g., inadequate preconditioning or canister purge during test); this may result in cheaper and more effective vehicle repair; and

iv) directly to consumers, to alert consumers of the likelihood that their particular vehicle will fail an I/M test; this may raise general awareness of importance of in-use emissions, and perhaps influence the purchase of used vehicles.

If I/M test results by model are not consistent across State programs, EPA should examine whether inconsistencies are due to differences in State I/M programs or regional differences that may affect in-use emissions. The data can be used to suggest changes to individual State I/M programs to make them more effective in identifying and repairing high emitters.

4. Recommendations on cost-effective emission reduction under I/M

Recommendation that EPA assist States by developing a high/low-emitter profiling protocol

The EPA should continue to facilitate the development and use of test regimes that focus testing resources on the highest emitting vehicles and therefore improve the cost-effectiveness of I/M programs. Examples include development of methods for high-emitter profiling and programs that exclude low emitting vehicles from testing. EPA should work to develop estimates for realistic credits under these types of programs. The approach already developed for California could be modified to provide other States with the capability of high-emitter profiling at a relatively low cost.

Recommendation that EPA allow States to adopt more flexible emission reduction programs, while maintaining levels of credits received through traditional I/M programs

The EPA should encourage States to use fees in lieu of testing for vehicles which are exempt from testing under profiling programs. These fee revenues should be used to reduce emissions in cost-effective ways. For example, States that adopt clean screening could collect testing fees, some of which are recycled to reduce emissions through repair subsidies, enhanced enforcement, or other programs shown to be cost-effective. The EPA

should make these options part of the Guidance on Clean Screening and Low and High Emitter Profiling and should develop ways to include SIP credits for such programs.

OBD Recommendation

This recommendation deals with finding the best regulatory program that provides drivers with the right incentives to allow OBD to replace traditional I/M.

5. Recommendation for modification to future OBD systems to eliminate the need for special trips to an emission testing station

EPA should expeditiously develop a program that will eliminate the need for motorists to make special trips to emission testing stations. The program should involve modification to current OBD requirements that will allow automated and tamperproof transfer of OBD status to appropriate regulatory authorities.

EPA should require a separate tamperproof permanent memory module to be permanently attached to the vehicle which stores at a minimum the memory module serial number, vehicle VIN, engine family code, applicable emission limits, accumulated mileage, OBD fault codes and mileage when they were triggered, and mileage when repairs are made and OBD fault codes are corrected. EPA should work with automobile manufacturers and vendors of current permanent memory systems to speed development of a low cost, standardized system.

EPA should rely on the current State of California efforts to develop cost-effective OBD cell phone transmission technology for transmission of OBD data. EPA should encourage California to maintain an option for driver initiation of the cell phone call, in addition to a possible automatic or interrogative call capability. A final decision on whether this system would be required on all vehicles or offered as an option should be decided after further evaluation of public and political sentiments. As a backup alternative, EPA should also design and evaluate a system to download permanent memory data at gasoline stations to a central computer through simple hookup to the OBD connector.

EPA should also join with the California ARB to further clarify requirements for current OBD connectors to the vehicle OBD II system. These connectors should be more standardized in terms of location. EPA should expedite this process with emphasis on a requirement that the connection be located in an extremely user friendly place, so that this system is potentially capable of quick and easy use by motorists at gas stations as an alternative to cell phone transmission of OBD status. EPA should require auto manufacturers to indicate the actual location of the OBD connector in the owner's manual. EPA should place high priority on completing the pilot project with the State of Wisconsin of developing a central computerized system capable of quickly downloading OBD II data from the vehicle OBD connector.

The EPA should monitor the performance of OBD systems as vehicles age to determine if current standards to which fault codes are set are consistent with cost-effective repair of older vehicles. To the extent fault code settings become a problem for aging vehicles, the EPA should examine options for modifications of Federal OBD settings that are fully tamper resistant and that maintain the integrity of vehicle software systems.

Additionally, efforts should continue to develop a direct vehicle emission measurement system to provide the most accurate means of assessing the overall effectiveness of the vehicle emission control system and provide the most equitable means for possibly imposing a vehicle emission fee.

Other Recommendations (Promoting Innovative Programs, Providing Emission Information to Consumers, and Linking Registration to Recall)

6. Recommendation that States be granted flexibility in developing innovative and incentive based policies for State SIP credit

The EPA should continue to move in the direction of allowing more flexibility in how States meet emission reduction targets for reducing in-use vehicle emissions. To this end, the EPA should support work by States on ways to develop methods of estimating emission reduction credits for innovative and incentive-based policies and on methods of on-going evaluation and enforcement of such policies.

7. Recommendation on vehicle indexing

The Workgroup recommends that the U.S. EPA evaluate and then consider implementing a vehicle emission information program to better publicize emission information about new light-duty passenger transport vehicles. Emissions information should include HC, CO, NO_X and CO_2 information. In considering development of the program, the U.S. EPA should:

i) Examine the existing smog index labeling program developed in California (current and proposed programs);

ii) Consider a single set of emission indices for all light-duty passenger transport vehicles. The current trend in light-duty vehicle purchasing shows an increasing consumer preference towards sport-utility vehicles and pick-up trucks. A consequence of this shift in vehicle selection is the increase in tailpipe emissions associated with these vehicles, which are currently subject to less stringent emission standards than passenger cars. Creating a single set of emission indices for all light-duty vehicles (passenger cars, pick-up trucks, mini-vans, and sport-utility vehicles) would make consumers aware that purchasing these larger and heavier vehicles rather than conventional passenger cars has a greater impact on air quality.

iii) Evaluate and consider using existing vehicle labels (e.g., the fuel economy label and the under-the-hood emission label) to provide consumers and others with emission performance information; and

iv) Evaluate and consider, beyond possibly making emission information available on vehicle labels, the content and means of publicizing more comprehensive information designed to facilitate the understanding of the relative emission performance of new vehicles.

8. Recommendation to enforce regulation that requires vehicles recalled for emissions-related problems to be fully repaired, by linking registration to recall completion

The EPA should continue working to implement a Federal program that ensures recalled vehicles are fully repaired before registration renewal is granted. EPA should consider the possibility of designing the program after the current emissions recall program in California, which appears to be quite cost-effective. If EPA chooses to develop a different type of program, at a minimum, the Federal program should run in harmony with California's. Then EPA should offer incentives to States to deny vehicle registration renewal if required recall repairs have not been performed. One possible incentive is to allow States to take credit for emissions related recalls that are performed. EPA should develop a protocol that allows States to get that credit. Other incentives should be explored.

The EPA should establish a national database of recalled vehicles. Vehicles that move out of one State and into another could be tracked using this database. This database would make the management of a registration-based recall program easier and more cost-effective.

1.0 Introduction

This report presents the development, research, and recommendations of the Innovative and Incentive Based Policies Workgroup. The Workgroup formed under the Mobile Sources Technical Review Subcommittee to investigate innovative and incentive based policy options for the reduction of in-use vehicle emissions. Section 1 of the report contains the background and charter of the Workgroup, Section 2 describes the process of the Workgroup, including a list of meetings and presentations heard by the Workgroup, and Section 3 presents the recommendations developed by the Workgroup.

1.1 Background

The Innovative and Incentive Based Policies Workgroup of the Mobile Sources Technical Review Subcommittee (MSTRS) was formed to examine innovative and incentive based policies and to develop recommendations that provide opportunities to reduce in-use vehicle emissions. The Workgroup formed in response to specific suggestions about the use and encouragement of innovative or incentive-based policies that were discussed as part of the deliberations of the In-Use Deterioration Workgroup (another workgroup under the MSTRS). While there are other workgroups under the Clean Air Act Advisory Committee looking at incentive based policies, the Innovative and Incentive Based Policies Workgroup was asked to look specifically at policies that might reduce in-use vehicle emissions and at ways to improve the efficiency of current emissions reduction programs or policies, such as State vehicle inspection and maintenance programs. The Workgroup met several times over the course of a year to share ideas and conduct research on these topics.

Other FACA Groups Working on Incentive Policies

- Subcommittee on Ozone, PM and Regional Haze Implementation Programs
  Chair: Alan Krupnick
  In transportation area, focused on incentive policies for off-road diesel engines.
- Linking Energy, Transportation and Air Quality Subcommittee
  Chair: Bob Wyman
  Looking at land-use, location efficient mortgages, and congestion/pollution issues.
- Economic Incentives and Regulatory Innovation Subcommittee
  Chair: Ben Henneke
  Reviewing EPA's revised guidance on Economic Incentive Programs; e.g. emissions trading and environmental justice issues.
- New Energy, Clean Air and Climate Change Subcommittee
- OTAG Mobile Source Incentives Group
  Chair: Mark Brownstein

Early on, the Workgroup decided to define incentives broadly to include not just direct monetary incentives like fees or scrap offers but also incentives that might more indirectly affect costs, such as policies that provide information to drivers about vehicle emissions or that affect the frequency of emissions inspections. The idea of incentive policies was broadened further to include policies that provided non-monetary incentives. The "currency" to which States or even mechanics respond are, in many cases, not monetary. For example, States may be more concerned with emission reduction credits to show compliance with regulatory requirements and mechanics with keeping clients satisfied. The Workgroup, therefore, felt it was important to keep the definition of incentives broad, recognizing that all policies provide some incentives, and the goal of improving policies should be to design the incentives to achieve real reductions in mobile source emissions.

In the early stages, a broad range of possible topics for the Workgroup to pursue were suggested by participants. Three major areas of focus emerged as being worth the focus of initial, intensive efforts: first, could current I/M programs be made more effective and cost-effective by incorporating policies that provided better incentives to motorists, mechanics and States to reduce emissions?; second, following recommendations from the In-Use Deterioration Workgroup to move quickly to adopt OBD systems as an alternative to traditional I/M, how could such a transition occur that would maintain or even enhance motorist and mechanic incentives to reduce emissions?; and finally, was there useful information about vehicle emissions or emission rates that had the potential to reduce vehicle emissions? Workgroup members decided to form three sub-Workgroups, or technical teams, to conduct more intensive research on these topics.

Three teams were formed to pursue specific research goals of the Innovative and Incentive Based Policies Workgroup:

- *the **Inspection and Maintenance (I/M) team**, to develop ideas for the more efficient application or implementation of I/M programs and program data;*
- *the **On-Board Diagnostics team**, to research the potential for and encourage compliance through the use of on-board emissions diagnostics technologies; and*
- *the **Emissions Information team**, for investigating the role of consumer information as a means to promote lower in-use emissions goals.*

More detail on the work of the three technical teams is presented in Section 2.2.

The decision was made to defer in-depth analysis of other topics that had come up in discussions. Some of these other topics that the Workgroup considered important but which were deferred for later analysis or for consideration in other FACA workgroups were: innovative or incentive-based policies that would affect emissions from heavy-duty engines, policies that would influence the age mix of the vehicle fleet such as old car scrap policies, and various vehicle and fuel taxation policies (some of these policies were considered briefly under the general category of incentive policies discussed in Recommendation 3.6 and in the cost-effective I/M policies in Recommendation 3.4 below). Policies directed specifically at heavy-duty engines

are being handled by another FACA group and some of the taxation issues are targeted to be discussed in other FACA groups.

The Workgroup is made up of representatives from the U.S. EPA, State governments, vehicle manufacturers, academia, and non-profit and other organizations. The three co-chairs are: Erik Herzog, from the Environmental Protection Agency's Office of Mobile Sources; Virginia McConnell, from Resources for the Future and the University of Maryland; and Bruce Bertelsen, from the Manufacturers of Emission Controls Association. A complete list of members is included in Appendix A.

There are eight Workgroups under the MSTRS, each formed to address a particular substantive issue. Operating on different time schedules, the various Workgroups of the MSTRS have developed or are developing recommendations for the full subcommittee to consider and forward to EPA. The individual workgroups are expected to coordinate their efforts through the MSTRS. Exhibit 1-1 shows the various Workgroups under the MSTRS and their schedules. More information on the other Workgroups can be found at: http://transaq.ce.gatech.edu/epatac/.

EXHIBIT 1-1
MOBILE SOURCES TECHNICAL REVIEW SUBCOMMITTEE WORKGROUPS

Workgroup Name	Co-Chair(s)	Dates/Status
Compliance	Jane Armstrong, EPA	7/95 - Now in Rulemaking Phase
Emission Modeling	Randy Guensler, Georgia Tech and Lois Platte, EPA	9/95 - Underway
Heavy-Duty Engines	Alan Lloyd, Desert Research Institute, Tom Bond, BP Oil, and John Wall, Cummins	Underway Experiments, data reconciliation, and statistical analysis underway.
Incentives	Bruce Bertelsen, MECA, Erik Herzog, EPA, and Virginia McConnell, RFF	07/97 - 01/99 Recommendations 1/99
In-Use Deterioration	Tom Cackette, CARB, and Bob Slott, Consultant for Shell Oil	Recommendations 7/97 Workgroup formally concluded.
Lab Upgrades	Bob Jorgensen, Cummins, and Mike Sabourin, EPA	07/97 - Present Delivered review of EPA's Lab Upgrade Plan
On-board Diagnostics	Ed Gardetto, EPA and Jerry Gallagher, Colorado Department of Public Health	1/98 - Present Underway
Phase II RFG	Debbie Wood, EPA and John Hornback, Kentucky DEP	4/97 - Present Underway

1.2 Charter

The Workgroup was formed and held its first meeting in July 1997. During the second meeting of the Workgroup in October 1997, the Workgroup adopted their charter statement. Exhibit 1-2 presents the charter adopted by the Workgroup on October 14, 1997. This Report summarizes the major issues and policies discussed by the Workgroup, and makes a number of recommendations to EPA based on extensive discussions within the Workgroup and review of existing policies around the country.

EXHIBIT 1-2: CHARTER STATEMENT
INNOVATIVE AND INCENTIVE BASED POLICIES WORKGROUP

The Innovative and Incentive Based Policies Workgroup will examine policies that provide opportunities to complement existing EPA and State policies for reducing vehicle emissions. The Workgroup will focus primarily on policies that offer economic incentives to motorists, mechanics, governmental agencies and others to reduce emissions in cost effective ways. Policies that provide nonmonetary incentives will also be considered.

The Workgroup will focus on policies that affect in-use vehicle emissions. Several general policy areas related to in-use emissions will be identified and explored in detail by the Workgroup. Innovative and incentive based policies will be evaluated to determine if they are feasible, politically acceptable and effective for reducing in use emissions. The Workgroup will coordinate its efforts with other groups who are examining or who have an interest in possible incentive based policies, including the OMS, and the Air Office at EPA, other FACA Subcommittees, Ozone Transport Assessment Group (OTAG), Environmental Council of States (ECOS), California Air Resources Board (CARB), South Coast Air Quality Management District (SCAQMD), and the Federal Highways Administration (FHWA).

The Workgroup will write summaries of the most promising policies. Workgroup members will write or provide outlines of the various policies to be considered, with the format of the summaries determined by the Workgroup. These will be edited and compiled into a paper, with an introduction and overview of the value of and role for incentives in mobile source policy. Finally, based on its review of the policies, the Workgroup will make recommendations to the OMS about the role of incentives, and particular policies that should be considered or promoted by the OMS, or the States.

Committee Membership. The Workgroup will have at least two co-chairs, and be made up of representatives of a variety of groups that have an interest in policies to reduce mobile source emissions. A number of members of the Technical Advisory Subcommittee on Mobile Sources have expressed an interest in serving on the Workgroup, but others from outside the Subcommittee will also be invited.

Charter of the Innovative and Incentive Based Policies Workgroup, Adopted October 14, 1997.

2.0 Workgroup Process

The Workgroup developed recommendations through formal meetings and through the work of three teams, each with a different focus. During the meetings, the Workgroup hosted a number of speakers on a range of topics, from the potential for publishing emissions information for consumer use to statistical analysis of in-use emissions to improve evaluation of I/M. The three technical teams, focusing on inspection and maintenance programs, on-board diagnostic systems, and emissions information, developed most of the background materials and the text of recommendations for presentation to the full Workgroup. A team membership list is included in Appendix B.

2.1 Meetings

The Workgroup meetings were used as a means to discuss and develop recommendation ideas, drawing on all existing research or program information available from around the country. The Workgroup met formally seven times between July 1997 and October 1998. Most of the meetings were held over a full day usually in conjunction with the full Mobile Source Technical Review Subcommittee meetings. The Workgroup met once in Los Angeles, California at the same time and location as the NAMVECC meetings in March 1998 to facilitate learning more about some of the innovative programs run by the State and other governmental entities in California. In addition to the formal meetings, the Workgroup held a series of conference calls to discuss selected topics in more depth, and faxes and e-mails were exchanged among members in between meetings.

The remainder of this section contains exhibits listing the dates, locations, speakers, and main topics discussed at each of the full Workgroup meetings.

EXHIBIT 2-1: July 15, 1997
Meeting Held in Washington, DC (Dupont Plaza Hotel)

Speakers & Topics:

- **Alan Krupnick**, Resources for the Future, spoke about the relationship of Innovative and Incentive Based Policies Workgroup to other FACA groups;
- **Roland Hwang**, from the Union of Concerned Scientists, presented on policies for providing information to consumers about in-use emissions;
- **Tom Wenzel**, from Lawrence Berkeley Laboratory, presented evidence on average in-use emissions and failure rates by make and model;
- **John Ellis**, from California's Bureau of Automotive Repairs, spoke about high-emitter profiling in California and about OBDIII;
- **John DiCicco**, of ACEEE, gave a presentation on integrated green vehicle methodology; and
- **David Dickenson**, from EPA OMS, discussed the Green Car Award program.

EXHIBIT 2-2: October 16, 1997
Meeting Held in Washington, DC (Dupont Plaza Hotel)

Speakers & Topics:

- **Rick Barrett**, State of Colorado, presented an overview of a consumer information programs operating in Colorado. In Denver, vehicle owners failing I/M tests receive packets containing diagnostic emissions information and names and rankings of participating mechanics. Colorado is developing a consumer information guide that will include vehicle failure rates.
- **Antonio Santos**, MECA, gave an overview of California's Gold Shield Program, operated by the Bureau of Automotive Repairs.
- **Virginia McConnell**, RFF, presented results of a RFF study comparing Arizona IM240 and FTP data.
- **Janet Hathaway**, NRDC-San Francisco, provided the Workgroup with an overview of repair cost assistance and repair cost ceiling initiatives in California.
- **Doug Berens**, Ford Motor Company, gave an introduction to the technical aspects of OBD systems.
- **Joe Belanger**, Connecticut, presented a status report on Connecticut's I/M program. Connecticut will have an IM240 program and will include cost caps on repairs.
- **Mark Warren**, Automotion (representing the repair industry), spoke to the Workgroup about mechanic's data needs to promote more effective repair.
- **Bob Knoll**, Consumers Union, spoke about the potential for emissions data to be published in upcoming car purchasing guides.
- **Tom Wenzel**, Lawrence Berkeley Laboratory, discussed the possibilities for using failure information for in-use compliance testing.

EXHIBIT 2-3: January 13, 1998
Meeting Held in Arlington, VA (Doubletree Hotel)

Speakers & Topics:

- **Erik Herzog**, EPA/OMS, outlined the Economic Incentives Program rule and the Voluntary Measures program. The Voluntary Measures program was finalized in 1997 by EPA.
- **Lori Schmidt**, EPA/OAR, provided an overview of emission indexing of new cars under the California and Federal programs.
- **Jane Armstrong**, EPA/OMS, discussed the Compliance Assurance Program (CAP2000), particularly the incentive policies for new car certification.
- **Jason Mark**, Union of Concerned Scientists, presented information about the California Heavy-Duty Engine initiative, which focuses on NOx emissions.
- **Dennis Koepke**, State of Wisconsin, gave an overview of the work and progress of the Environmental Council of States (ECOS) on I/M issues. The ECOS group has only made progress on short term evaluation.

EXHIBIT 2-4: March 25 and 26, 1998
Meetings Held in Los Angeles, CA (Regal Biltmore Hotel)

Speakers & Topics:

- **Marty Keller**, Bureau of Automotive Repair (BAR), presented the long-term opportunities for California incentive programs.
- **Dave Amlin**, BAR, gave an update on evaluation and technical issues raised under California's incentive programs.
- **Mark Carlock**, California Air Resources Board (CARB), provided a program description of the California Emissions Inventory programs.
- **John Urkov**, CARB, discussed California's program that links recall to registration, including details on the costs and emissions savings estimated for the program.
- **Bob Slott**, Consultant for Shell Oil, provided results of research using remote sensing to measure I/M effectiveness.
- **Koji Okawa**, Toyota, provided analysis supporting Toyota's recommendation for a high-emitter correction for the MOBILE6 model.
- **Dick Gibbs**, New York State, gave the Workgroup an update on the ECOS process.
- **Laki Tisopulos**, South Coast Air Quality Management District, provided an overview of market-based mobile source policies in the Los Angeles region.
- **John Kowalczyk**, Oregon Department of Environmental Quality, summarized the OBD team's ideas on potential applications for OBD technology.

EXHIBIT 2-5: April 14, 1998
Meeting Held in Washington, DC (Washington Plaza Hotel)

Speakers & Topics:

- There was only one formal presentation during this meeting. For the majority of the time, the Workgroup discussed developing recommendations.
- **Bob Slott**, Consultant for Shell Oil, provided the Workgroupwith a report on remote sensing data and analysis.

EXHIBIT 2-6: July 14, 1998
Meeting Held in Ann Arbor, MI (EPA Vehicle Testing Facility)

Speakers & Topics:

- **Joe Somers**, EPA OMS, provided the Workgroup with a presentation on the Clean Screen Guidance and High and Low Emitter Profiling.
- **Susan Field**, Toyota, summarized their research on in-use deterioration modeling and presented their recommendation for the Workgroup.
- **Ed Gardetto**, EPA OMS, reported on the work of the OBD Workgroup.

EXHIBIT 2-7: October 15, 1998
Meeting Held in El Monte, CA (CARB Testing Laboratories)

The Workgroup worked on the text of the recommendations report for the duration of the meeting.

2.2 Overview of issues discussed by Workgroup and Subgroups/Teams

The Workgroup intent was to explore a range of innovative policies that might improve the incentives that motorists, mechanics and States face to reduce vehicle emissions. The Workgroup, meeting as a whole, heard from many different individuals about innovative policies going on in States around the country. Then, the issue related groups, or technical teams, had further discussions and conducted additional research that allowed detailed exploration of potential options or recommendations when selected issues were determined to be too complex or too early in development to be adequately treated by the full Workgroup. The three subject areas require additional attention by the issue teams were: Inspection and Maintenance (I/M) programs; On-Board Diagnostics (OBD) technology; and the issues concerning the use and dissemination of emissions information. Other topics, such as repair assistance programs and linking registration to recall, were discussed by the full Workgroup.

2.2.1 Inspection and Maintenance Programs

The Workgroup as a whole and the I/M Policies team spent a good deal of time considering innovative policies and ways to improve incentives for I/M programs that would help to make these programs more effective and more cost-effective. Various ways to improve the incentives that drivers, mechanics, and States face under I/M regulations were discussed. Initially, the Workgroup intended to examine incentive policies that would complement existing I/M regulations. However, it quickly became clear that there are major barriers to improving I/M efficiency given the way credits are granted through the MOBILE model and the SIP process. The Model awards credits for I/M programs with a fairly lenient burden of proof; therefore, it is easy to receive credits beyond actual emissions reductions. Innovative programs may result in real emissions benefits, but unless those benefits are both quantifiable and large enough to exceed the model-driven emission reduction estimates, States will not receive credit for the

programs. This situation creates little incentive for States to spend additional money developing creative approaches to I/M programs. In addition to the Workgroup consideration of these issues, the ECOS group had been intending to address these long-term evaluation issues, but has recently abandoned such efforts (October, 1998). This makes Workgroup recommendations on these issues all the more important.

The following outline describes many of the ideas that were discussed, some of which resulted in specific recommendations to the EPA (see Section 3 for the recommendations).

Consider incentives to States under current regulations. Current methods for granting credits for existing mobile source policies do not always offer the right incentives to States to reduce emissions. For example, States run the MOBILE model (TECH IV component) to get credits for their I/M programs - the credits generated often appear to be generous or higher than actual reductions that occur. Therefore, States have little incentive to evaluate I/M program actual emissions reductions - they may even have a disincentive to do so because if they do evaluate they are likely to discover that the modeled emissions credits they have taken are too large.

The Workgroup discussed three different ways to deal with this problem, each of which is described briefly below. One is to try to "fix" the Model to make it more flexible and better able to reflect the actual performance of I/M programs. The second attempts to provide incentives for States to do better than modeled emissions reductions, and to prove how well they are doing by performance measures. The third is to require States to validate or confirm credits taken by the Mobile Model using real world evaluation protocols.

(1) Examine how credits are granted for I/M programs in the MOBILE Model. The Workgroup looked at the assumptions of the Mobile Model and at how the Model is used to estimate SIP credits. The compliance rate as it is used by States, combined with repair effectiveness assumptions built into the Model, seem to overstate emission reductions that occur under I/M. Evidence from the Arizona IM240 program showed that up to one third of the vehicles that failed the I/M cut points were never verified as eventually passing. In addition, 40 percent of the vehicles that are repaired fail their next test two years later; the Mobile Model does not account for this. If the Model continues to be used to generate emission reduction credits from I/M, it should be revised and not overstate those emissions reductions.

(2) Revise MOBILE Model credit generation and allow States to show that they are doing better than Modeled credits. To pursue ideas to improve incentives for States, The Workgroup discussed the possibility of making the Model conservative in its estimation of potential emissions reductions from I/M and then allow States to show they are doing better to gain more credits. There was concern that this might be politically difficult because it would require a revision to the SIP process that would result in "taking back" credits that have already been

granted to States. However, this type of change in the credit granting process could be made for future SIP submittals.

(3) Move toward a system in which States must confirm/prove credits estimated by the MOBILE Model. Proof that the reductions had occurred would be done by real world program evaluation. Protocols for how such an evaluation could be done would be developed by the EPA. If the reductions were not proved, they would revert to some lower default level. The evaluation would require that States collect I/M program data, determine how many failing vehicles actually get repaired in each I/M cycle and how much their emissions are reduced.[1] On road assessments would also have to be done to determine the appropriate baseline emissions which are from both tested and untested vehicles. Only tested vehicles have the potential to result in emissions reductions under the I/M program. (see Recommendation 3.2 and Appendix C for a more detailed description of data that would have to be collected by States and for suggested evaluation methods).

Examine the current and potential use of data on failure rates for I/M programs. Vehicle owners and mechanics might find the results of I/M testing stratified by make, model, and model year of vehicle useful in their purchasing decisions or in their ability to diagnose emissions problems. The State of Colorado produces a "Green Card" that summarizes information from the I/M program about failure rates by make and model and provides vehicle owners with a list of mechanics willing to be ranked by their performance record in repairing failing vehicles. This is discussed more in section 2.2.3.

Change the frequency of inspection as vehicles age or by characteristic of vehicle. Some States already waive vehicles from testing in the initial years of vehicle life. Cost savings may be realized by changing the frequency of testing at several times during the lifetime of a vehicle. For example, more frequent (i.e., annual or biannual) tests would only be required for older, more likely to fail, vehicles. The Workgroup heard presentations about the current California program which targets high emitter vehicles for more frequent inspections (see Recommendation 3.4).

Examine cost-effectiveness of tighter I/M cut points. As cut points are tightened, it may become more difficult to repair marginally polluting vehicles. This may make I/M programs very expensive for consumers. There is currently very little evidence about the effectiveness or cost-effectiveness of tightening cut points in I/M programs. There may be some impact on how many vehicles get repaired or how many are driven illegally as cut points are tightened.

Explore the idea of a "Green Wrench" award. This type of program would either rank or award mechanics or vehicle repair shops that achieve a specified level of success

[1] However, it is not necessarily the case that previously failing vehicles that pass subsequent tests have had successful repairs. Data from both Arizona and Colorado programs have shown that vehicles that fail once are likely to fail again.

repairing emissions problems. Another idea that was discussed was the program in British Columbia that attempts to give incentives to motorists to get repairs done at facilities with well trained mechanics. In this program, if a vehicle fails I/M test, the retest fee is reduced (or eliminated) if repairs are done by certified repair facility - certified facilities have mechanics who have been through a certain amount of diagnostic and repair training. This program also gives repair facilities an incentive to have trained mechanics. Another idea is to have "gold repair" shops that guarantee repair to their customers. Such a program creates a type of insurance system and currently is being tried in California.

Consider how current programs emphasize vehicle repair over vehicle maintenance. Under the current programs, particularly the design of SIP credits, it is easier to receive rewards for stimulating repair than for stimulating maintenance, largely because the demonstration of effective repair is more straightforward than showing that vehicles are being properly maintained. Currently, States have incentives to emphasize repair over maintenance. For example, States get SIP credit when they find more failures (and therefore may impose tighter cut points) or when they force repairs (States may choose to create higher limits for waivers), but there are no rewards through SIP credits for I/M programs that inspect for gas cap, spark plug, ignition wire, air filter, or fuel filter replacement. Further, unscheduled on-road emissions testing may spur maintenance, but there is no mechanism to give States credit for those types of programs.

Analyze the potential for mandatory maintenance programs. The Workgroup briefly discussed the idea of mandatory parts replacement programs to promote vehicle maintenance. An analysis would have to be done on whether widespread replacement of any such parts would be cost-effective. The parts most often discussed were requiring gas cap or spark plug replacement, although oxygen sensors and catalyst retrofit replacement were also discussed.

2.2.2 Use of On-Board Diagnostics

The On-Board Diagnostics team discussed the potential for the use of OBD in place of, or as a supplement to, I/M testing. The OBD team also discussed the potential for improving OBD to better serve testing and informational demands, such as by developing OBD systems with permanent memory. A primary concern from the OBD group is that these options might become less attractive as vehicles age because OBD is designed to alert drivers to emissions problems at 1.5 times the new car certification standard. The EPA recommended final IM240 cut points for model year 1991 and newer vehicles that are several times that of the new car certification standards. Therefore, it is possible that vehicles with illuminated MILs would pass I/M testing. This may result in drivers ignoring illuminated MILs, particularly for vehicles that are no longer under warranty, thereby reducing the effectiveness of the OBD system as a means to encourage emission system repairs. Or, it is possible that some of these repairs triggered by a light on may not be very cost-effective, particularly for older vehicles (i.e., some repairs could be very expensive and produce very little emission reduction). In either case, the Workgroup sees

potential problems with the on-off nature of the OBD MIL light, set at a tight standard, particularly as cars age past the warranty period. This potential problem could be addressed by following the part of Recommendation 3.5 relating to automatic reset of specific fault trigger codes as vehicles age.

The OBD group developed recommendations on the topics outlined below.

- Consider incentives for consumers to respond to a malfunction indicator light (MIL). The OBD team spent a lot of time discussing methods that might prompt consumers to make more timely repairs in response to an illuminated MIL. These ideas fell into two general categories: altering the operation or reducing the function of the vehicle, and reducing the regulatory burden for vehicle owners to respond to illuminated MILs.

  (1) Impairing the vehicle as a means to encourage repair. The team, and the Workgroup, decided that impairing the operation or restricting the other features of the vehicle (e.g., disabling the air conditioner or radio) would raise too many safety concerns and liability issues.

  (2) Allow a waiver of the I/M test if motorist responds to an illuminated MIL. This option would let motorists skip the I/M test if they show proof of repair related to a MIL illumination since the last I/M test.

- Investigate technology options to use in the replacement of I/M testing. OBD could be used as a tool for checking the emissions performance of vehicles. Owners could bring vehicles into testing facilities for a scan of their OBD memory or the OBD information could be accessed remotely, thus freeing consumers from making a special trip to a vehicle testing facility. The OBD team discussed the various options for replacing traditional I/M testing with OBD at length and developed a matrix of options for consideration in formulating a specific recommendation. The matrix is included in Appendix D.

- Consider improvements to current OBD technology: Expand memory and access to OBD and emissions information. OBD could be designed to include a "vehicle tracking system" where repair history, I/M test results, and maintenance records could be stored and accessed by regulators or testing facilities. Also, eventual ability to measure actual emissions of vehicles may allow a broader range of policies in the future.

2.2.3 Emissions Information

The emissions information team focused its efforts on assessing the type of vehicle emission information that would be most valuable to the public and the methods by which the information could be distributed.

Early Workgroup discussions centered on rankings for new cars based on emissions. It was agreed that emissions rankings for new cars only makes sense when there are a range of different standards to which cars are being built. That appears to be the case in today's market, because there are different truck and car standards and differences in ratings between cars certified to California standards versus vehicles certified to the Federal standards and NLEV requirements. The Workgroup had a presentation from Lori Schmidt of the EPA about the range of different standards to which new cars are subject. Consumers often do not know that there are emission differences among vehicles, so they are unlikely to be making informed purchasing decisions based on the emissions potential of their vehicles. The Workgroup debated the impact of this information on consumer purchasing decisions.

The Workgroup also discussed at length the value of providing information about the emissions performance of used cars. A presentation on the potential for Consumer Reports to publish information on emissions performance, such as I/M failure rates and emissions repair information, was given by Bob Knoll at an early Workgroup meeting. The Workgroup decided to look at the available data on failure rates and repair. This work was done primarily by the I/M team (see above).

Emissions information about used vehicles can take a number of forms:

- Emissions indexing. Emissions indexing is a means to provide consumers with more information as they choose either a new or a used vehicle. Allowing consumers to make a choice between vehicles with more information about the relative emission levels for each vehicle is likely to promote higher sales of the lower-emitting vehicles.

  (1) New Cars. Light-duty vehicles certify to a variety of different emission standards. In purchasing a new vehicle, it would be beneficial to the consumer and others to have information available to them that explains, in an easy to understand manner, the emission performance of that vehicle relative to other new vehicles. The Workgroup discussed the merits of a Federal vehicle emission information program to educate consumers and others on the emission performance of new vehicles. The Workgroup discussed the efforts in California to develop their Smog Index labeling program as a guide for developing a Federal program. (See Recommendation 3.7.)

  (2) Older Cars. Ranking of older cars by model and model year according to emissions rates has been suggested because of the wealth of data available from on-going I/M programs. However, some Workgroup members pointed out that there may be problems with consistency of datasets between locations and testing programs. [2] Locational differences in results on the same vehicle could occur due to different climates, altitudes, or seasons. Some subgroup members suggested

[2] However, the data presented in Appendix E show that there is consistency between Arizona and Colorado test results by make and model year of vehicle.

an alternative to avoiding the consistency concerns would be to use automobile manufacturer's in-use FTP testing results.

- Information about I/M performance or repairs upon sale of vehicle. Requiring vehicle owners to disclose results of past I/M tests and subsequent repairs when selling a vehicle might help promote emissions-related repairs. The suggestion was made that States could go further and allow public access to I/M results for individual vehicles.

- Information about vehicle failures and repair effectiveness. Rick Barrett described some of the things Colorado is doing to use information to help make the fleet cleaner. They are developing a program that provides information on vehicle failures and mechanic (shop) performance to consumers. Consumers can access a list of repair shops that shows a ranking of participating shops based on their success fixing failed vehicles. Colorado is also compiling a list of vehicles, by make and model year, with the expected failure rate for each group based on past I/M performance. This list, called the "Green Card" is being made available to Colorado residents.

3.0 Recommendations

This section contains recommendations developed by the Workgroup over the past year. Meetings and conference calls have served as the Workgroup's forum for discussing the research, policies, and programs that have inspired recommendations to complement existing Federal, State, and local policies to reduce vehicular emissions. For each recommendation, this section will provide: a background of the recommendation, technical or political issues regarding the recommendation, a justification or rationale for the recommendation, and finally the language of the recommendation itself.

I/M Recommendations

As the Workgroup began to look at State and local use of innovative and incentive-based policies, it became apparent that a major obstacle to their use is the way emission reduction credits are granted using the MOBILE emission factor model. States obtain credits for their I/M programs by running the MOBILE Model, but that Model does not provide a realistic, validated measure of the actual emission reductions being achieved by their particular I/M program. Further, the "performance standard" to which States enhanced I/M programs have to be compared has also not been adequately benchmarked to real world data. As a result, States do not have any way of evaluating the benefits of incentive measures added to current regulatory programs since these benefits are often already "taken" in the modeled credits. The first two recommendations below deal with improving the assessment of existing I/M programs by utilizing more real-world benchmarking and evaluation of these programs. These improvements are a necessary prerequisite for creating an environment that encourages the use of innovative and market-based incentives in I/M programs.

3.1 Recommendation that the I/M component of the MOBILE model be modified to more closely reflect real-world performance of State I/M programs

In order to allow States to determine the cost-effectiveness of various types of I/M programs and to allow the comparison of I/M with other policies to reduce vehicle emissions, including innovative and incentive-based policies, it is essential that the emissions forecasts of the MOBILE Model be as accurate as possible.

i) The Model should be made to more closely reflect the performance of existing I/M programs by drawing on evidence from on-going programs. The "performance standard" for Enhanced I/M should be examined to determine if it reflects what it is feasible for I/M programs to achieve.

For running the Model, States should be required to input local parameters, and should not be allowed to use default values for key Model parameters such as fleet mix, compliance, etc.

ii) The I/M component of the MOBILE Model should also be modified to make critical assumptions within the Model (e.g., repair effectiveness and emissions changes resulting from non-compliance and other imbedded assumptions) more clear to States. States should be encouraged to compare evidence from their programs to what is being assumed in the Model. If States implement policies that improve some aspect of their I/M program, they should be allowed to change parameters to reflect those changes in the Model runs.

iii) The EPA should develop more complete guidance for States on how to define and estimate I/M non-compliance rates, which are an input to the I/M component of the MOBILE Model. As part of this guidance, EPA should require States to determine if all failing vehicles have completed the program, and if they have not, to reflect that fact in the compliance rate used in running the Model. Then, the EPA should work with the States to develop ways of estimating, through such methods as license plate identification or DMV records, how many of the failing vehicles that have not been repaired are still being driven in the I/M region.

Support and Rationale for Recommendation

The assumptions underlying the I/M emission reduction forecasts as they are made within the Mobile Model are not easy to check against actual performance in State programs. Assumptions about repair effectiveness and changes in emission reductions through non-compliance are imbedded within the Model code. These assumptions could be made more transparent so that States can compare the modeled results to the results they see in practice. For example, the "performance standard" for enhanced I/M assumes emissions reductions associated with pressure and purge testing. However, purge testing is not done in any enhanced I/M programs.

In general, to the extent the TECH model continues to be used to evaluate I/M, the Workgroup would like to see certain aspects of the model reexamined. The TECH model, makes assumptions about repair effectiveness and emissions losses from non-compliance based on small laboratory data sets. These assumptions should be compared to evidence from on-going programs as data become available.

The Compliance Rate. States are actually supposed to input the compliance rate to the MOBILE Model, which is defined as the proportion of vehicles in the eligible fleet which complete I/M testing. States tend to use rates of 96 or 97 percent or higher, which suggests they are only looking at the percent of vehicles tested, not the percent of vehicles in compliance. The percent of failed vehicles that neither pass nor get a waiver, or are not removed from the airshed should also be considered as noncompliant.

There appear to be a large number of vehicles that fail the test and do not actually complete repairs and pass, or receive a waiver. For example, there is some initial

evidence from Arizona that up to one-third of vehicles which fail I/M are not getting repaired (at least there is no record of a passing repair within a year of the failing test). It is not clear what is happening to these vehicles, and currently States which are only concerned about SIP credits have no incentive to track them down. As a result, they are using compliance rates that are too large and modeled results that tend to overestimate emission reductions.

Repair Effectiveness. Repair effectiveness in the TECH model is based on a relatively small number of vehicles repaired in a laboratory setting. This evidence should be compared to evidence from State I/M data on repair effectiveness. A protocol for assessing repair effectiveness by the States should be developed. This information could be compared to emission reduction credits from the Model.

Emissions from vehicles driving in the I/M area that are not participating in the I/M test program. In running the Model, States should have to start from an initial fleet of vehicles including those that are driven in the I/M region but are not tested in the I/M program. This would include transient vehicles and vehicles owned by students, military personnel, Federal government agencies, etc., that are not tested. The I/M program reduces emissions only from those vehicles which are tested and which receive repairs if they are failing. (See Appendix C.)

3.2 Recommendation that EPA require States to perform *ex post* evaluations of the effectiveness of I/M programs, in order for States to claim emission reduction credits from these programs

Real world evaluation is essential for allowing comparisons among policies for achieving real and cost-effective emission reductions. It is also important for determining the accuracy of the MOBILE Model forecasts for SIP credits and to allow comparisons across States with different programs.

EPA initiated an evaluation process for enhanced I/M programs as part of the original Enhanced I/M rule in 1992, but because of delays in program implementation, the first quantitative evaluations are not due for many States until the year 2000 or later. The EPA is in the process of developing methods States can use to evaluate I/M programs for this review. The Workgroup commends this effort. However, the Workgroup would like to see three additions to the current evaluation policy.

ii) Evaluations should be required for all I/M programs, not just for Enhanced I/M for the same reasons discussed above.

ii) The EPA should ensure that evaluations performed as part of the I/M rule be used to confirm emission reductions contained in the SIP as forecast by the MOBILE Model.

iii) Evaluation protocols should be developed that include both in-program data and out-of-program on-road data. In-program data will allow States to evaluate I/M programs based on vehicles that get tested, repaired, and retested. It does not reveal much about that part of the fleet that does not get tested, or about avoidance of the program. Using both in-program and out-of-program data will also allow States to identify the proportion of the fleet emissions that are part of I/M and to observe changes in that share over time. Currently, States assume a share of the fleet that participates in I/M, but that share is often not confirmed. Protocols would have to be developed for random sampling of vehicles in the I/M program, for how to measure emission reductions, and for location and timing of remote sensing/cameras or random roadside pullovers for out-of-program data.

Support and Rationale for Recommendation

Current estimates of emissions reductions come from emissions inventory models like MOBILE. These models are constructed from a variety of data sources, mainly FTP measurements conducted in laboratories from a limited number of volunteer vehicles.[3] Adjustments to the model are made based on other vehicle activity data and emissions measurements (such as trip logs and tunnel studies) in an attempt to make the MOBILE more representative of real world emissions. The fleet used for data in the models inherently lags behind current on-road fleet technology because of time necessary to recruit vehicles, run FTPs, and amend the model. Repair effectiveness for I/M calculations has been based entirely on pre-1990 vehicles repaired in the laboratory by skilled technicians aware that they were part of a test program.

Emissions reduction estimates based on the Model are used by States to generate emission reduction credits for their I/M programs into the future. To the extent that these estimates of effectiveness overstate the emissions reductions that actually occur, States have little incentive to attempt to evaluate the emission reductions actually occurring in their programs or to explore innovative policies that might be more effective at reducing emissions. The Workgroup believes that ways to promote more on-going evaluation will be critical to the effectiveness of future mobile source emission reduction policy.

Although current regulations require States to evaluate their programs, few have attempted to do so. The ECOS process, which began in response to a requirement of the Federal

[3] These vehicles are generally recruited through mail solicitation for which there may be a selection bias. At this time, there is no evidence of the direction or the magnitude of the possible bias.

Highway Bill, was designed to help identify methods of evaluation for decentralized programs. The Workgroup has had a number of briefings from ECOS representatives about their deliberations on the short-term evaluation of decentralized I/M which involves only qualitative measures. The ECOS discussion of longer-term evaluation had been intended to provide more of a quantitative assessment, similar to the evaluation the Workgroup believes important. However, the ECOS group has now disbanded, so this recommendation becomes all the more important. Recently, the National Academy of Sciences has begun a new evaluation of the MOBILE model, including a review of the I/M component of that Model.

Evaluation of emission reduction benefits from I/M programs should ideally include both in-program and out- of-program data. Analysis of in-program data would provide a measure the emission reductions actually occurring as a result of repairs under I/M. This could be done by testing a random sample of vehicles in the I/M program on a consistent test procedure, such as a IM240, or an equivalent Mass Emissions Transient Test (METT). A State that is unable to use IM240 or equivalent METT could use an alternative quantification protocol for estimating exhaust emissions changes as a result of I/M. In program data can also be used to measure long-term repair effectiveness. Vehicles can be tracked over time through I/M program records to determine how long repairs have lasted. Evaporative emissions changes are more difficult to measure than exhaust emission reductions. On vehicles equipped with OBD II systems, useful data can be captured about all types of component failures and whether they get repaired.

Out-of-program assessments done through remote sensing or random roadside pullovers could be used to confirm the amount of on-road emission reduction that has taken place. Out-of-program remote sensing can also estimate in-use deterioration of different groups of vehicles (e.g., initially passed vehicles, repaired vehicles, etc.) between I/M test cycles. Cameras with license plate readers can estimate the driving frequency of failed vehicles that never pass I/M as a function of the time after failure, as well as seeing how many untested vehicles are being driven in a region. Remote sensing measurements on a sample of these vehicles can estimate what percent of total light duty vehicle emissions they represent. Although these assessments are subject to uncertainty, so too are the modeled estimates of emissions reduction. Each can supplement the other. The data collection for evaluation involves both in-program and out-of-program data. Examples of the kind of data to be collected and analyses that could be performed are summarized in Appendix C.

The Workgroup believes that such evaluations should be required for confirmation of credits that have been forecasted to obtain SIP credits. However, the Workgroup felt it would not be fair to States to change the SIP rules in midstream. Hence, the confirmation policy should be phased in, and only be required for new or revised SIP submittals.

3.3 Recommendations on the evidence and use of vehicle emissions information from I/M data

Recommendation on I/M Test Data

EPA should require States to be prepared to provide raw I/M test result data to EPA on demand that would allow the EPA to assess the consistency and validity of the evidence on emissions and failure rates by make, model, engine size, and vintage. EPA should provide guidelines to States on the format and variables to be included on data submissions to EPA. The data submitted to EPA should be made available for analysis by other researchers.

Recommendation on analysis of I/M Program Data

EPA should continue to analyze State I/M program failure rates and average emissions by model year, make, model, engine size, and, to the extent possible, fuel delivery system. The data should be analyzed to determine if there is consistency in failure rates and average emissions by model across different State I/M programs. The analysis should consider differences in State I/M programs, such as type of emissions tests, cut points, use of fast-pass or fast-fail algorithms, etc., as well as regional differences that may affect emissions, such as average temperatures, fuel composition, and altitude. Interested parties should be allowed a period to review the analysis and provide comments to EPA.

If I/M test results by model are consistent across State programs, EPA should consider distributing the data to several audiences, for different uses:

i) internally and to CARB, to be used to identify vehicle models for more detailed in-use emissions compliance testing; this may result in better use of limited compliance testing resources;

ii) to States, to be used to update high- and low-emitter profiles used to require more frequent I/M testing of likely high-emitting vehicles or to excuse likely low-emitting vehicles from I/M testing; this may result in more cost-effective I/M programs;

iii) to States, vehicle manufacturers and dealers, and repair facilities, to be used to identify vehicle models with common emissions problems and repairs, as well as false failures due to details of the I/M program (e.g., inadequate preconditioning or canister purge during test); this may result in cheaper and more effective vehicle repair; and

iv) directly to consumers, to alert consumers of the likelihood that their particular vehicle will fail an I/M test; this may raise general awareness of importance of in-use emissions, and perhaps influence the purchase of used vehicles.

If I/M test results by model are not consistent across State programs, EPA should examine whether inconsistencies are due to differences in State I/M programs or regional differences that may affect in-use emissions. The data can be used to suggest changes to individual State I/M programs to make them more effective in identifying and repairing high emitters.

Support and Rationale for Recommendations

Analysis of in-use emissions data from large numbers of vehicles, measured either in State I/M programs or by remote sensing, indicates that there is a wide range in failure rate and average emissions by vehicle model, even for models that are less than five years old. The Workgroup heard a presentation from Colorado on the "Green Card" program, which provides consumers with a rating of I/M failure rates and average repair costs by vehicle model. The I/M Effectiveness-Information team was formed to determine whether a similar national ranking of models by I/M test result was practical, as well as to identify other potential uses for State I/M test result data.

The I/M team sought any evidence that information on the in-use emissions of a given vehicle model has any affect on which models consumers purchase. A representative from Consumers Union attended a meeting, and stated that he believed such information would be valuable to consumers; however, no studies or other evidence on the potential effect of such data were identified.

An important issue to address in order to determine the usefulness of I/M test results by vehicle model is to determine if the data are relatively consistent across State I/M programs. If rankings by model are consistent across States, then the data from a few States can be used nationally. If rankings are not consistent, then the data may be useful in identifying differences in I/M program testing protocols that result in different rankings for the same vehicle models. Inconsistency in model data across States should not preclude individual States from making use of their own program data (such as publishing rankings of vehicle models similar to Colorado's "Green Card").

The I/M team examined failure rates by vehicle year, make and model in three different I/M programs; the results are summarized in Appendix E. The analysis found reasonable agreement in I/M results by vehicle model; however, it was decided that more research is needed to better determine consistency across State I/M programs. Based on these results, the entire Workgroup revised and agreed to several recommendations about how best to use I/M test result data.

Providing I/M test results by vehicle model to consumers is a contentious issue. Manufacturers design vehicles to pass in-use certification testing done on a detailed driving cycle under carefully controlled conditions; I/M tests are not as carefully controlled as certification testing. Vehicle manufacturers in the Workgroup expressed concern that some models may be mis-identified as high emitters in the I/M data. For example, a known limitation of existing IM240 programs is that vehicles are not consistently preconditioned prior to testing; if emissions from a certain model are particularly sensitive to inadequate preconditioning, this model may be identified as a high emitter in the I/M data. The Workgroup tried to address this concern in its recommendations that only peer reviewed data be released to the public, and that the data be used to help identify the extent of such problems and alert States as to which models are affected.

3.4 Recommendations on cost-effective emission reduction under I/M

Recommendation that EPA assist States by developing a high/low-emitter profiling protocol

The EPA should continue to facilitate the development and use of test regimes that focus testing resources on the highest emitting vehicles and therefore improve the cost-effectiveness of I/M programs. Examples include development of methods for high-emitter profiling and programs that exclude low emitting vehicles from testing. EPA should work to develop estimates for realistic credits under these types of programs. The approach already developed for California could be modified to provide other States with the capability of high-emitter profiling at a relatively low cost.

Recommendation that EPA allow States to adopt more flexible emission reduction programs, while maintaining levels of credits received through traditional I/M programs

The EPA should encourage States to use fees in lieu of testing for vehicles which are exempt from testing under profiling programs. These fee revenues should be used to reduce emissions in cost-effective ways. For example, States that adopt clean screening could collect testing fees, some of which are recycled to reduce emissions through repair subsidies, enhanced enforcement, or other programs shown to be cost-effective. The EPA should make these options part of the Guidance on Clean Screening and Low and High Emitter Profiling and should develop ways to include SIP credits for such programs.

Support and Rationale for Recommendations

Although State I/M programs have traditionally required the inspection of all vehicles at regular intervals, there has been some interest lately in modifying programs to focus testing efforts only on those vehicles that are more likely to be high emitters, and to exempt from testing those vehicles that are likely to be low emitting. High-emitter profiling policy that requires vehicles identified as most likely to fail an I/M test be tested more frequently. The current

California high-emitter profiling policy was discussed by the Workgroup in some detail (see summary of the presentation by Dave Amlin of the California Bureau of Automotive Repair (BAR) below).

Another approach is to profile low-emitting vehicles, allowing them to be tested less frequently. Either or both of these will make an I/M program more cost-effective and also provide incentives to drivers to keep cars clean and/or to select low emitting vehicles.

An alternative to high/low emitter profiling is to exempt the newer model year vehicles because fewer of them are likely to fail (even under stricter I/M cut points) than older vehicles. This could also make programs more cost-effective compared to testing all vehicles by targeting resources to finding and repairing high emitting vehicles.

A third way to improve cost-effectiveness is to clean screen vehicles by the use of remote sensing measurements (RSD). Vehicles identified by RSD as low emitters may be exempted from their next I/M test. EPA has just completed draft Guidance for States for implementing a clean screen program.

The Workgroup discussed the fact that there may be some social and political problems with profiling because low-income groups are likely to benefit least from their implementation. To the extent that low income households have older vehicles, and have fewer resources for maintenance and repair, their vehicles are likely to be required to have relatively more frequent testing under either a high or low profiling policy or more time consuming testing under a clean screen policy.

However, there are significant advantages to profiling policies. They are likely to improve the overall acceptance of I/M programs, because most vehicles will require less frequent or faster testing than under current programs. To the extent that they can reduce I/M program costs, programs will be more able to achieve emissions goals, and even go beyond them.

Evidence from California. The Workgroup was briefed by Dave Amlin of the California BAR at the March 25th meeting about the High Emitter Profile program currently in effect in California. With Radian International as the contractor, California developed a program to identify potential high emitters. The program uses information about the individual vehicle including past I/M failures and remote sensing observations, and general emissions information about the vehicle's make, model year and engine family. The data used for the analysis is extensive: ten million records per year are used to refine the high emitter profiling. The strongest indicator to predict failure is the historical emissions of engine families. BAR has already included Arizona and Colorado data to improve the profiling, and plans to update the models with ASM data when that data are available.

Mr. Amlin reported that using high-emitter profiling would allow the State to save a substantial amount of money by testing only the highest emitting vehicles. After testing 10 percent of the fleet selected using high-emitter profiling, 45 percent of the very-high and 60 percent of the supers were captured. Increasing the test to 20 percent of the fleet captured 50

percent of the very high and 70 percent of the super emitters. Table 3-4-1 shows the estimated cost per ton reduced resulting from profiling in California. High-emitter profiling was found to work well with HC, but not with NOx.

Table 3-4-1
Cost-Effectiveness by Percent of Fleet Tested

Percent of Fleet Tested (using high-emitter profiling)	Marginal Cost per Ton ($HC + NO_x + CO/7$)
10%	$3,225
20%	$5,670
30%	$5,467
40%	$5,546
50%	$8,331
60%	$19,898
100%	$286,419

Source: Dave Amlin, BAR, presentation on March 25 in Los Angeles.

California also did some analysis comparing low-emitter profiling to exempting vehicle up to five years old from emissions testing. Table 3-4-2 shows estimates from California of the emissions savings lost under a low-emitter profiling program compared to a program based on straight five year exemption. Low-emissions profiling may have the potential to be more cost-effective than granting model year exemptions, but the public perception and legislative willingness to adopt LEP have been barriers to implementation.

Table 3-4-2
Emission Savings Lost:
Low-Emitter Profiling vs. Model Year Exemptions
(percent lost compared to testing all vehicles)

	HC	NO_x	CO
Low-Emitter Profiling (cleanest 10%)	1.1 %	-	2 %
Model Year Exemption (first five years)	7.3 %	8.5 %	11.2 %

Source: Dave Amlin, BAR, presentation on March 25 in Los Angeles.

Since California has made a large up-front investment for high-emissions profiling, other States can now implement their own profiling system for approximately $100,000 -- this allows Radian to adapt and install the necessary software to conduct emissions modeling.[4]

Cost-Effective Emission Reduction Packages. One major barrier to the use of these more cost-effective test regimes is that many States are struggling to achieve higher emission

[4] Dave Amlin, presentation to Workgroup on March 25, 1998.

reductions. Although the above described programs may be more cost-effective, they often fall short of the emission reductions that would have been achieved in a program that tests all vehicles at regular intervals. For example, the draft Clean Screen Guidance that was just released by the EPA assumes that Clean Screen programs will result in about 90 percent of the emission reductions of a traditional biennial program.. The Workgroup feels that it is important that EPA allow States to include additional ways to reduce emissions as part of a cost-effective I/M package. For example, if vehicles that are clean-screened or are otherwise tested less frequently must still pay an I/M fee, then the money collected could be used to reduce emissions to achieve the same or greater emissions reductions goals as the traditional program. For example, the money could be used to repair vehicles that might not otherwise be repaired under the I/M program (e.g., the disappearing vehicles) or to improve enforcement efforts. This type of clean screen plus fee with additional emission reduction policies should be one option described in the Clean Screen Guidance document.

OBD Recommendation

3.5 Recommendation for modification to future OBD Systems to eliminate the need for special trips to an emission testing station

EPA should expeditiously develop a program that will eliminate the need for motorists to make special trips to emission testing stations. The program should involve modification to current OBD requirements that will allow automated and tamperproof transfer of OBD status to appropriate regulatory authorities.

EPA should require a separate tamperproof permanent memory module to be permanently attached to the vehicle which stores at a minimum the memory module serial number, vehicle VIN, engine family code, applicable emission limits, accumulated mileage, OBD fault codes and mileage when they were triggered, and mileage when repairs are made and OBD fault codes are corrected. EPA should work with automobile manufacturers and vendors of current permanent memory systems to speed development of a low cost, standardized system.

EPA should rely on the current State of California efforts to develop cost-effective OBD cell phone transmission technology for transmission of OBD data. EPA should encourage California to maintain an option for driver initiation of the cell phone call, in addition to a possible automatic or interrogative call capability. A final decision on whether this system would be required on all vehicles or offered as an option should be decided after further evaluation of public and political sentiments. As a backup alternative, EPA should also design and evaluate a system to download permanent memory data at gasoline stations to a central computer through simple hookup to the OBD connector.

EPA should also join with the California ARB to further clarify requirements for current OBD connectors to the vehicle OBD II system. These connectors should be more standardized in terms of location. EPA should expedite this process with emphasis on a requirement that the connection be located in an extremely user friendly place, so that this system is potentially capable of quick and easy use by motorists at gas stations as an alternative to cell phone transmission of OBD status. EPA should require auto manufacturers to indicate the actual location of the OBD connector in the owner's manual. EPA should place high priority on completing the pilot project with the State of Wisconsin of developing a central computerized system capable of quickly downloading OBD II data from the vehicle OBD connector.

The EPA should monitor the performance of OBD systems as vehicles age to determine if current standards to which fault codes are set are consistent with cost-effective repair of older vehicles. To the extent fault code settings become a problem for aging vehicles, the EPA should examine options for modifications of Federal OBD settings that are fully tamper resistant and that maintain the integrity of vehicle software systems.

Additionally, efforts should continue to develop a direct vehicle emission measurement system to provide the most accurate means of assessing the overall effectiveness of the vehicle emission control system and provide the most equitable means for possibly imposing a vehicle emission fee.

Support and Rationale for Recommendation

There continues to be public and political unrest about current I/M programs, including their administrative costs. The burden placed on States to implement or oversee these programs is great. Issues about tampering and circumvention of the program have some validity, especially considering statistics that indicate a substantial percentage of vehicles that fail I/M tests "disappear" from the program. The need to make a special trip to a testing station and spend time waiting for the test seems to be particularly bothersome to the public. For instance, opinion surveys in Oregon and Florida of motorists at I/M stations indicate more than 70 percent feel a program should be developed that identifies polluting vehicles and insures repair without requiring vehicles to periodically go to a station for an emission test. About 60 percent felt is would be worth additional cost to new vehicles to equipment them with technology that would enable implementation of such a program.

From an administrative cost standpoint, California indicates more than $240 million a year are spent conducting vehicle emission testing with $170 million of that amount spent on testing "clean" vehicles. The proportion spent on testing clean vehicles is expected to increase in the future in all States. Another FACA Workgroup dealing with OBD is developing guidance for implementation of a program to shift current exhaust emission checks to an OBD II system check at testing stations. The Innovative and Incentive Based Polices Workgroup supports this effort. While the switch to an OBD II system check at testing stations will somewhat reduce costs per

test, it will not reduce the major administrative cost associated with testing clean vehicles, it will not eliminate the need for a special trip to a testing station and it will not offer additional incentives for more timely repair. Therefore, further changes to the OBD system as recommended herein, should be pursued.

The Innovative and Incentive Based Policies Workgroup has extensively studied the issue of the need to develop a replacement for traditional I/M programs and possible options. After numerous discussions and extensive evaluations, the Workgroup concluded that there is a need for expeditiously developing and implementing a program that will offer States and the public hope for an ultimate replacement for traditional I/M with a program that meets the following objectives:

1) is at least as effective as current I/M programs;

2) is more acceptable to the public;

3) motivates more timely repair;

4) does not require a motorist to make a special trip to a testing station; and

5) has minimal administrative costs.

The Workgroup has based its recommendation on the premise that:

1) there will be a continuing need and public expectation that excessively emitting vehicles will be repaired;

2) most of the public would prefer a program that does not require motorists to make a special trip to a testing station;

3) OBD II systems will identify excess emission problems at least as effectively as IM240;

4) a significant number of motorists will not make repairs to emission control systems when the MIL illuminates, particularly after warranties expire; and

5) an advanced technology system can be developed to meet the objectives for a replacement program which is not subject to significant tampering.

The Workgroup chose its recommendation from among many possible options[5] on the basis that OBD data transfer by vehicle cell phone is developed technology, that this approach would be the most automated and least effort method for motorists to provide information on the

[5] A matrix containing the options considered by the Workgroup in developing this recommendation is included in Appendix D.

status of their OBD system, and that it would offer other benefits to motorist in terms of immediate repair service assistance in cases of vehicle malfunction. With this system, excess emissions could still be addressed using vehicle registration as an enforcement tool.

Permanent memory separate from the vehicle computer was considered essential with whatever option was recommended. Permanent memory offers the following advantages: 1) it provides a tamperproof means of transmitting OBD fault code status, 2) it provides data on the timeliness of vehicle repair (length of time MIL is illuminated) and 3) it can provide an accurate means of recording odometer data. Public knowledge that the length of time the MIL is illuminated would be permanently stored could provide an incentive for more timely emission control system repair, particularly if regulatory agencies were to charge an excess emission fee for length of time and seriousness of the emission control problem and/or if vehicle manufactures linked warranty provisions to timely repair. A side benefit of this system would enable supplementing or conversion of the current gasoline tax system to a more equitable mileage based approach. This could become much more important for transportation system financing in the next century when expected major increases in fuel economy and more widespread sales of alternative fueled vehicles cause major reductions in gas tax revenue.

The Workgroup believed that the cost for implementation of its recommendations would be significantly less than the cost of current I/M programs when cell phone transmission systems and permanent memory modules are mass-produced. The OBD connection and centralized computer system for OBD data download at gas stations is recommended as a backup system. Continuing to develop this system as a backup was felt desirable by the Workgroup in case the cell phone transmission system encounters political or economic difficulties for full scale mandatory application and because it would have minimal cost. Either system would necessitate some administrative support for receiving and processing data but certainly far less than is expended conducting traditional I/M testing.

The Workgroup recommendations should not be construed to imply that traditional I/M programs would be able to be repealed in the near future. The recommended program would take several years to implement on new vehicles and it would take several more years for these vehicles to represent a significant portion of the fleet. Nevertheless, the Workgroup recommendations do offer the possibility of an orderly and progressive phase out of traditional I/M testing while continuing to insure long-term effective emission control performance of vehicles.

It should be noted that there will be drawbacks with this or any other option that uses OBD as an emission evaluation tool as the vehicle ages. The Workgroup is concerned about the uniform requirements that all fault code triggers occur at the same 1.5 times the standard for all vehicles. It is possible that some vehicles as they age will have particular difficulty meeting that standard in a cost-effective way. The recommendation that EPA examine options for modification of OBD settings can avoid requiring motorists to make repairs that are not cost-effective or encouraging motorists to ignore illuminated MIL's.

Other Recommendations (Promoting Innovative Programs, Providing Emission Information to Consumers, and Linking Registration to Recall)

3.6 Recommendation that States be granted flexibility in developing innovative and incentive based policies for State SIP credit

The EPA should continue to move in the direction of allowing more flexibility in how States meet emission reduction targets for reducing in-use vehicle emissions. To this end, the EPA should support work by States on ways to develop methods of estimating emission reduction credits for innovative and incentive-based policies and on methods of on-going evaluation and enforcement of such policies.

Support and Rationale for Recommendation

In recent guidance, the EPA has allowed States to obtain credit for innovative policies in situations where full approval could not be given under current regulatory authority. The guidance, called the "Voluntary Measures Policy" focuses on mobile source control programs undertaken by local governments or private entities where authority to enforce the program is often lacking. Currently, most of the policies being developed under this guidance involve changes in emissions as a result of changing vehicle use, such as parking programs or congestion mitigation programs. There are, however, a number of innovative policies that involve reductions in emissions through changes in the fleet mix or in individual vehicle emission rates. To the extent these policies result in real emission reductions, they should get the associated emission reduction credits. For example, a policy that taxes high emitting vehicles will change the fleet mix, resulting in lower fleet-wide emissions.

Among States and others outside EPA, there is often a sense that innovative and market incentive policies are not treated on an equal footing with regulatory programs. Whereas certain existing in-use policies, such as I/M, receive large credits readily available through the MOBILE model. Policies for which such credits are not readily available, such as incentive policies can only take emissions reductions that have not already been taken, and have to prove measurement and determine uncertainty bounds, which is seen as a significant additional hurdle for State and local implementers. Such uncertainty bounds are already built into the model for current regulatory programs based upon data collected and analyzed by EPA. To the extent that the model allows States to claim credit very easily for emissions reductions that are more generous than the actual reductions that are occurring, there will be little incentive to introduce new programs that have the potential to achieve real emission reductions. This difference in treatment is primarily due to the fact that estimates of the emission reduction potential of some policies have been developed by the Agency, and others have not. The Agency has focused its attention on a limited number of policies, principally those mandated by the Clean Air Act, since assessment of the potential effects of policies and design of Guidance documents can be time consuming and complex. Enforcement and oversight of existing regulations can also involve considerable resources. However, we believe that the EPA could work with the States on

promising innovative or incentive-based policies to develop guidance and estimate of emission reductions.

3.7 Recommendation on vehicle indexing

The Workgroup recommends that the U.S. EPA evaluate and then consider implementing a vehicle emission information program to better publicize emission information about new light-duty passenger transport vehicles. Emissions information should include HC, CO, NO_X and CO_2 information. In considering development of the program, the U.S. EPA should:

i) Examine the existing smog index labeling program developed in California (current and proposed programs);

ii) Consider a single set of emission indices for all light-duty passenger transport vehicles. The current trend in light-duty vehicle purchasing shows an increasing consumer preference towards sport-utility vehicles and pick-up trucks. A consequence of this shift in vehicle selection is the increase in tailpipe emissions associated with these vehicles, which are currently subject to less stringent emission standards than passenger cars. Creating a single set of emission indices for all light-duty vehicles (passenger cars, pick-up trucks, mini-vans, and sport-utility vehicles) would make consumers aware that purchasing these larger and heavier vehicles rather than conventional passenger cars has a greater impact on air quality.

iii) Evaluate and consider using existing vehicle labels (e.g., the fuel economy label and the under-the-hood emission label) to provide consumers and others with emission performance information; and

iv) Evaluate and consider, beyond possibly making emission information available on vehicle labels, the content and means of publicizing more comprehensive information designed to facilitate the understanding of the relative emission performance of new vehicles.

Rationale and Support for Recommendation

Light-duty vehicles used for passenger transport (passenger cars, pick-up trucks, mini-vans, and sport-utility vehicles) certify to a variety of different emission standards *(see Table 3-7-1 showing the various exhaust emission certification standards in the United States*). In purchasing a new vehicle, it would be beneficial to the consumer and others to have information available to them that explains, in an easy to understand manner, the emission performance of

that vehicle relative to other new vehicles. Environmental considerations appear to be at least one of the factors of interest to households when they consider new car purchase decisions. Therefore, the Workgroup recommends that the U.S. EPA develop a Federal vehicle emission information program to educate consumers and others on the emission performance of new vehicles. As part of this program, the Workgroup further recommends that the U.S. EPA evaluate and consider implementing a vehicle emission index labeling program taking into consideration California's smog index labeling program.

With finalization of the National LEV program in the U.S. earlier this year, the need for a Federal vehicle emission information program has become more apparent. Under National LEV, the different emission standards that vehicles must certify to will increase in number and complexity starting in 1999. In 1999 and 2000, National LEV vehicles will be sold in nine Northeastern States and the District of Columbia, California vehicles will be sold in New York and Massachusetts, and Tier 1 vehicles will be sold in the 37 remaining States. In 2001 and later, California vehicles will be required in New York, Massachusetts, Maine, and Vermont and NLEV vehicles will be required in all of the remaining States (until replaced by Tier 2 vehicles in the 2004-2006 time frame).

Although currently in the U.S. vehicle emission performance does not seem to be a major factor in consumers' decisions when purchasing a new vehicle, there is a need for the U.S. EPA to help consumers make more well-informed choices about the products they buy, similar to the Agency's existing consumer labeling initiative.[6] Raising consumer awareness regarding the relative environmental impact of new vehicles, may help over time to elevate the importance of vehicle emission performance in making purchase decisions.

If a Federal vehicle emission information program, including possibly a vehicle emission index labeling program, is successfully implemented, States could offer various transportation incentives to consumers and/or fleet operators who purchase low-emitting vehicles (e.g., employer-based commuting incentives, preferential parking, and exemption from certain transportation control measures). In addition, States and local governments could more easily identify low-emitting vehicles that could be purchased for use in government fleets. Finally, since automobile manufacturers have shown a growing interest recently in promoting vehicle emission performance in their industry, emission index information could facilitate efforts by automobile manufacturers to promote the environmental friendliness of their vehicles.

[6] In 1996, as part of the U.S. EPA's reinvention agenda developed in response to Vice President Al Gore's challenge to all Federal agencies to reinvent government so that it works better and costs less for the American people, the Agency developed a special initiative to improve consumer labeling information for pesticides, cleaning supplies, and other common household products. Under the program, EPA has made several changes aimed at making product labels more user-friendly, including how to standardize environmental information on the labels.

Table 3-7-1
Exhaust Emission Certification Standards for NMHC/NMOG, CO, and NOx (grams/mile)
Federal Test Procedure
Federal and California Programs

	Vehicle Type	Emission Category	5 Years/50,000 Miles			10 Years/100,000 Miles		
			NMHC/ NMOG	CO	NOx	NMHC/ NMOG	CO	NOx
Federal	LDV	Tier 1	0.25	3.4	0.4	0.31	4.2	0.6
	LDT1	Tier 1	0.25	3.4	0.4	0.31	4.2	0.6
	LDT2	Tier 1	0.32	4.4	0.7	0.40	5.5	0.97
	LDT3	Tier 1	0.32	4.4	0.7	0.46	6.4	0.98
	LDT4	Tier 1	0.39	5.0	1.1	0.56	7.3	1.53
California	PC	Tier 1	0.25	3.4	0.4	0.31	4.2	0.6
		TLEV	0.125	3.4	0.4	0.156	4.2	0.6
		LEV	0.075	3.4	0.2	0.090	4.2	0.3
		ULEV	0.040	1.7	0.2	0.055	2.1	0.3
		ZEV	0.00	0.0	0.0	0.000	0.0	0.0
	LDT1	Tier 1	0.25	3.4	0.4	0.31	4.2	0.6
		TLEV	0.125	3.4	0.4	0.156	4.2	0.6
		LEV	0.075	3.4	0.2	0.090	4.2	0.3
		ULEV	0.040	1.7	0.2	0.055	2.1	0.3
		ZEV	0.00	0.0	0.0	0.000	0.0	0.0
	LDT2	Tier 1	0.32	4.4	0.7	0.40	5.5	0.97
		TLEV	0.160	4.4	0.7	0.200	5.5	0.9
		LEV	0.100	4.4	0.4	0.130	5.5	0.5
		ULEV	0.050	2.2	0.4	0.070	2.8	0.5

Source: U.S. EPA (August 20, 1997)

California's Smog Index Labeling Program

In California, vehicle emission indices, called smog indices, were adopted for light-duty vehicles beginning in 1998 to provide consumers with an indication of the relative contribution of different new light-duty vehicles to smog formation based on their exhaust and evaporative HC and NOx emissions (*see Table 3-7-2 for a list of current California smog indices*). The smog index labels are affixed to a vehicle's front window. Indexing of new vehicles works by assigning a baseline value, usually 1.00, to a given emission standard (Tier 1, TLEV, etc.) and then setting all other index values relative to the baseline depending on the total emissions associated with each emission standard. Currently, in California, Tier 1 gasoline vehicles certified to the regular evaporative system (2.0 gram 1-hour diurnal plus hot soak HC per test at 50,000 miles) are assigned a baseline index value of 1.00 (see attached table listing the smog indices for vehicles in California). With the baseline value set, the other smog indices are calculated based on their emission category. For example, a ULEV (enhanced evaporative system) with a smog index of 0.34 emits 34 percent of the total emissions from a Tier 1 vehicle (regular evaporative system).

Table 3-7-2
Smog Indices for 1998 MY Passenger Cars and Light-Duty Trucks in California

	Smog Index	
Type of Vehicle	Passenger Cars and Light-Duty Trucks (0-3750 lbs LVW)	Light-Duty Trucks (3751-5750 lbs LVW)
Tier I (regular evaporative system)*	1.00	1.00
Tier I (enhanced evaporative system)**	0.70	0.77
TLEV (regular evap.)	0.89	0.89
TLEV (enhanced evap.)	0.59	0.67
LEV (regular evap.)	0.67	0.65
LEV (enhanced evap.)	0.37	0.43
ULEV (regular evap.)	0.64	0.62
ULEV (enhanced evap.)	0.34	0.39
ZEV	0.00	0.00

* regular evaporative system means vehicle meets the following standard for evaporative hydrocarbons:
diurnal + hot soak 2.0 g/test at 50,000 miles
** enhanced evaporative system means vehicle meets the following standard for evaporative hydrocarbons:
diurnal + hot soak 2.0 g/test at 100,000 miles
running loss 0.05 g/mi at 100,000 miles

California is currently revising its smog indices for the 2000-2003 model year vehicles as part of proposed amendments to its Low-Emission Vehicle regulations (LEV II). The major changes being proposed are: 1) assign 2000 model-year Tier 1 gasoline passenger cars a smog index value of 1.00, 2) create a single set of smog indices for all light-duty vehicles, 3) include diesel vehicles in the smog index calculation, and 4) include fleet average smog indices.

Table 3-7-3
List of Possible Vehicle Categories for a Federal Vehicle Emission Indexing Program for Passenger Cars and Light-Duty Trucks (1999-2003 MY)

Type of Vehicle
Tier 1 (LDT2s)
Tier 1 (PCS and LDT1s)
TLEV (LDT2s)
TLEV (PCS and LDT1s)
LEV/NLEV (LDT2s)
LEV/NLEV (PCS and LDT1s)
ULEV (LDT2s)
ULEV (PCS and LDT1s)
ZEV

3.8 Recommendation to enforce regulation that requires vehicles recalled for emissions-related problems to be fully repaired, by linking registration to recall completion

The EPA should continue working to implement a Federal program that ensures recalled vehicles are fully repaired before registration renewal is granted. EPA should consider the possibility of designing the program after the current emissions recall program in California, which appears to be quite cost-effective. If EPA chooses to develop a different type of program, at a minimum, the Federal program should run in harmony with California's. Then EPA should offer incentives to States to deny vehicle registration renewal if required recall repairs have not been performed. One possible incentive is to allow States to take credit for emissions related recalls that are performed. EPA should develop a protocol that allows States to get that credit. Other incentives should be explored.

The EPA should establish a national database of recalled vehicles. Vehicles that move out of one State and into another could be tracked using this database. This database would make the management of a registration-based recall program easier and more cost-effective.

Rationale and Support for the Recommendation

In the past ten years, many vehicles have been recalled due to emissions equipment-related recalls. However, the success rate for finding and fixing those emission-related problems is not high. Available evidence suggests that nationwide only about 30 to 40 percent of vehicles recalled under Federal statute have had complete repair.[7] The Workgroup has looked at this issue, and developed several recommendations for improving the success rate for repair of emission-related recalls.

The 1990 Clean Air Act, section 182 (a)(2)(B)(ii), stated that the EPA should issue a guidance which would provide "…assurance that a vehicle subject to a recall notice from a manufacturer has complied with that notice…" The EPA set up a committee in 1993 which included stakeholders from States and auto manufacturers to develop a program to assure recall compliance. No recommendations have come out of this process, and currently the Committee is inactive.

One way to improve recall effectiveness is to link vehicle registration to completion of emissions related recall repairs. Registration denial enforcement systems are perceived as effective in other contexts, such as I/M program enforcement. In addition, a registration-linked recall program seems to be working in California. The Workgroup heard from John Urkov of the

[7] Data received from Andy Brooks (U.S. EPA, Washington, DC). Vehicles recalled from manufacturers, under warranty, tend to have higher repair rates.

California ARB about the California registration-linked recall program at the March 24th meeting. The California program was put into place in 1994, and currently has a recall completion rate of over 90 percent. California had difficulties coordinating the program between the Department of Motor Vehicles and the California ARB during the first few years, but now has a smoothly running and relatively inexpensive program. Mr. Urkov reported that the cost of linking the recalled vehicles that have not been repaired to the registration data base is only several thousand dollars a year. He did not have any information about the potential emissions reductions that are obtained from such a program.

Several representatives from State government on the Workgroup expressed concern over whether the costs of registration based recall program would be worth the relatively small emissions reductions that would be obtained. At the moment, there is very little evidence about what the emissions reductions would be. The Workgroup asked both California ARB and the EPA if they had information about the magnitude of the emissions reductions, but to date there are no estimates. In addition, coordination through State departments of motor vehicles and across State lines for vehicles which move between States can be difficult. However, it is encouraging that California was able to put a program in place that, after several years, is inexpensive and works very smoothly.

States may need more of an incentive to take on the additional burden of a registration enforcement system. One possible incentive is to allow States to get credit for the emission reductions that occur as a result of the registration enforcement. EPA could use California's experience with the program as a guide or case study in developing a Federal protocol.

The program could be implemented by having manufacturers electronically submit a list of vehicle identification numbers for those vehicles that have not received recall repairs to a central location or to the individual States' appropriate registration renewal department. A communication system, the frequency for updating the no-recall-performed file, the length of time the no-recall-performed records must be held, and a back-up method for owners who did have the recall performed but are identified as not having the recall performed will need to be determined. Also, vehicles may have to be tracked if they move among States. Finally, some method for granting credit for the reductions would have to be determined.

Appendix A
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Appendix B
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Information About Emission Performance	I/M Effectiveness	OBD Issues
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Appendix C
Evaluation of I/M Programs

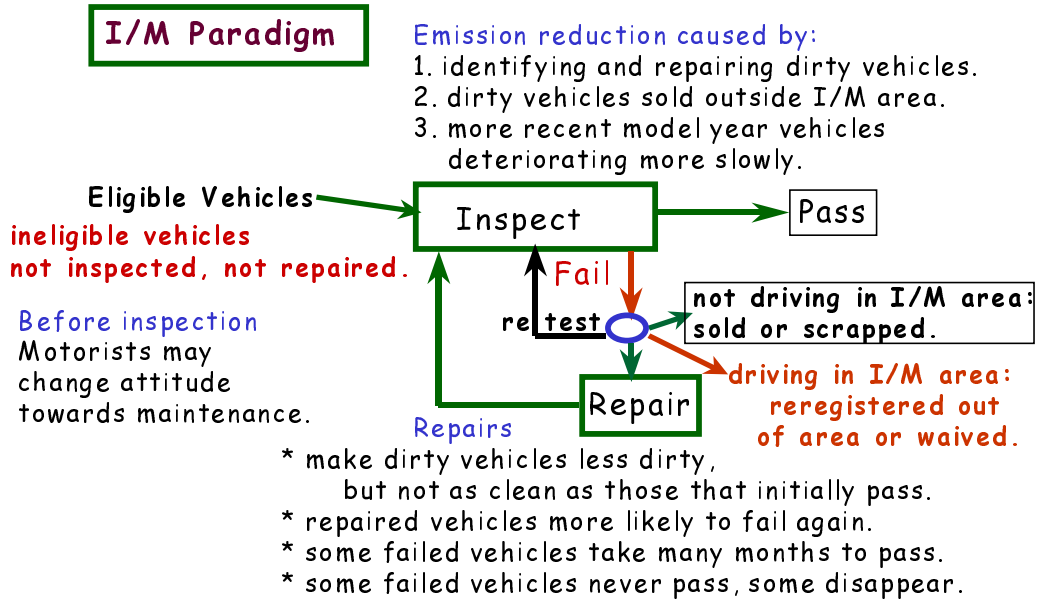
On-going evaluation of I/M programs will require that States collect both in-program and out-of-program data.

In-program data should include the following information for each vehicle: the VIN; the date and the time and the duration of each test (some programs allow fast pass or fast fail); the type of test; the odometer reading; the vehicle type; the vehicle model; the I/M history of the vehicle, both within a test cycle and earlier test cycles; the date most recently purchased; the exhaust emission cut points used; and, if repaired, the type of repair station, the cost, the type of repair, the percent of excess emissions reduced through repair as a function of the initial emission level, and what, if any, evaporative emission tests are used. Data grouped by model year should include: the percent of eligible vehicles tested; the percent of vehicles that fail; the distribution of the length of time between failure and repair; the percent of excess emissions reduced by repair as a function of the excess emissions ; the number of vehicles that are never repaired; the fate of vehicles never repaired (waived, scrapped, sold out of I/M area, unaccounted for); and the failure rate of previously repaired vehicles compared to the failure rate of previously passed vehicles.

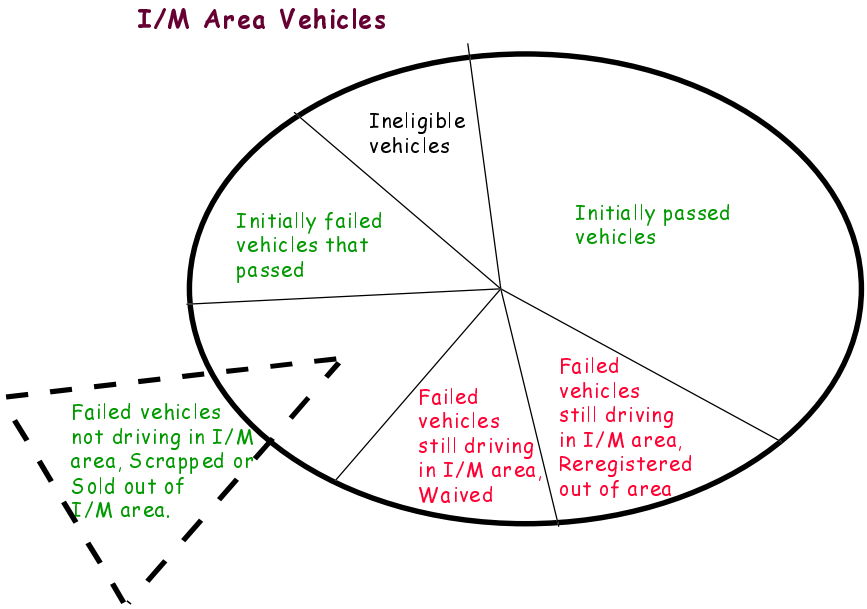
Out-of-program on-road data should include either/both remote sensing and random roadside vehicle pullovers with mandatory testing. On-road data should estimate the following by model year: total light duty vehicle emissions; percent of emissions in I/M eligible fleet; percent of I/M eligible vehicles driving in the air basin; percent of repeatedly seen vehicles in the air basin that are registered out of the I/M area; an estimate of the emission reductions of eligible vehicles based on length of time before and after inspection; an estimate of the failed and not repaired vehicle fleet that has left the I/M area altogether with the emissions reduced by their leaving; and the excess emissions of the eligible and the tested fleet.

An Overview of I/M Evaluation
By Bob Slott

The paradigm for I/M programs is



The vehicles driving in the I/M area can be classified as follows



The I/M program is successful if:

Vehicles that pass the test are low emitters.
Low emissions from failed vehicles driving in the I/M area.
Low emissions from ineligible vehicles repeatedly driving in the I/M area.

In order for vehicles that pass the test to be low emitters:

The test should identify when vehicles are low emitters,
(tailpipe, evaporative emissions, and visual inspections), and
Vehicles that are low emitters when they pass the test stay that way.

A suggested method for evaluating whether an I/M program is effective:

Overall Program Effectiveness: Determine what is the expected vehicle population and emissions for the I/M area, and compare this with the actual vehicle population and emissions.

- Given the location (north or south, east or west, urban or rural) and the socioeconomic makeup, estimate the vehicle emission population (VMT weighted vehicle type, model year distribution and emitter levels) using remote sensing. For areas which are starting an I/M program, get baseline vehicle emissions from before start of the program. Note that the vehicle emission population is dynamic because of fleet turnover and improving vehicle technology. For areas with an existing I/M program estimate vehicle emissions from similar areas where no I/M program exists.
- Measure the vehicle emissions in the I/M area and compare it with the expected vehicle emission population.

Program Element Effectiveness:

A. Vehicles that pass the test are low emitters:
   1. Tailpipe: compare remote sensing values by model year and vehicle type of passing vehicles, initially passing vehicles and initially failing vehicles separately, to vehicles of the same technology in different I/M programs with different vehicle test methodologies.
   2. Evaporative Emissions: compare evaporative emission testing done in the I/M program with evaporative emission testing done in a benchmark program using undercover audits of purposefully failed vehicles in both programs.
   3. Visual Inspections: compare visual testing done in the I/M program with evaporative emission testing done in a benchmark program using undercover audits of purposefully failed vehicles in both programs.

B. Low emissions from failed vehicles driving in the I/M area: Monitor vehicle populations in I/M area with video cameras. Use remote sensing to determine percent of emissions from a sample of failed vehicles still driving in I/M area.

C. Low emissions from ineligible vehicles repeatedly driving in the I/M area: Use video camera data to determine percent of ineligible vehicles repeatedly driving in the I/M area. Use remote sensing to determine the percent of emissions from a sample of the ineligible vehicles that are repeatedly driving in the I/M area.

D. Vehicles that are low emitters when they pass the test stay that way: Remote sensing monitoring shows deterioration rates of initially passed, repaired, and failed but not yet passed vehicles. Look at vehicles with high deterioration less than one month after test passed. Deterioration rates of repaired or attempted to be repaired vehicles monitored by station type, vehicle model, vehicle technology, etc.

E. Cost Effectiveness: Calculate cost of program including testing cost, motorist time cost, repair cost, monitoring and evaluation cost, outreach program cost. Divide cost into emissions reduced as determined by the Overall Program Effectiveness. Compare cost effectiveness with that of other I/M programs and other light duty vehicle emission reduction programs.

Appendix D
Options for Replacing I/M with OBD

Objective:

Utilize OBD II in a manner which will provide reasonably equivalent effectiveness compared to traditional I/M, will be relatively acceptable to the public, will have minimal administrative costs and will motivate timely repair, *while not requiring motorists to drive to a test station*.

Premise:

1. There will be a continual need and public expectation that excessively emitting vehicles will be repaired;
2. Most of the public would prefer a program that does not require a periodic visit to a testing station;
3. OBD II systems will identify excess emission problems at least as effectively as IM240; and
4. A significant number of motorists will not make repairs to emission control systems when the MIL illuminates, particularly after warranties expire.

Option	Function	Enforce-ment	Cov-erage	Timely Repair	Cost (Relative to other options)	Public/ Political Reaction	Tampering	Advantage	Other Comments
Transponder	Radio signal automatically triggered when MIL illuminates	I	H	H	Hardware - moderate Admin. - Moderate (to detect failures and follow up on repair)	Major privacy issue (1)	May not be able to overcome jamming signal device	Instantaneous identification of high emitters	No value from equipment in areas where enforcement program is not conducted
	Radio signal manually activated by driver	R	H	M	Same as above	Likely more acceptable then option above	Should not be a problem	Close approx. of current I/M approach	Same as above
Data Disk	Disk records OBD status and is sent in with vehicle registration	R	H	M	Hardware - Moderate/High Admin. - Low/Moderate	Probably high acceptance	In addition to encryption, other steps will be necessary to minimize	Same as above	Same as above plus repairs may be delayed until registration time, like current I/M
	Include permanent memory with above	?	H+	M-H	Same as above	Same as above	Same as above	Provides incentive for immediate repair	Covers vehicles in entire country
Inspection of MIL at Gas Station	Attendant checks upon request when registration and issues pass certificate for vehicle registration	R	H	L	Hardware - None Admin. - Low	Mixed - Suspicion of cheating prevalent	Significant cheating expected	Low cost/ Low tech option; can implement back to 1996 vehicles	Issuing registration at station could further reduce administrative costs
	Independent inspectors make random inspections	I	M	L-M	Hardware - None Admin. - Moderate, need many independent employees to be effective	Some feeling of "Big Brother"/ Police approach	Some possible cheating expected	Can implement back to 1996 vehicles	Some motorists will take risk of not getting inspected and not test vehicle

Option	Function	Enforce-ment	Cov-erage	Timely Repair	Cost (Relative to other options)	Public/ Political Reaction	Tampering	Advantage	Other Comments
Limit Operation of Vehicle	Performance (e.g., top speed, acceleration)	SELF	H+	H	Hardware - Low Admin. - None	Major safety / liability issue (1)	Should be able to design relatively tamper proof system	Self-enforcing relatively rapid repair expected	Reduces emissions prior to repair; covers vehicles in entire country
	Disable air conditioner	SELF	H+	M	Hardware - Low Admin. - None	Not a safety / liability issue; might be acceptable if there is an understanding this relates to limiting emission until repair is made; mixed views about affecting vehicles in entire country	Same as above	Self-enforcing, stimulates repair when most important (ozone season)	Same benefits as above; low income/old cars may not value, or not have, AC use and not repair vehicle
	Other (e.g., disable radio)	SELF	H+	L	Hardware - Low Admin. - None	Considered harassment	Circumvention by replacing radio relatively easy	Self-enforcing	Not of value to fix compared to cost of emission repair
Roadside Pullover Inspection of MIL	For emission check only	I	M	L-M	Hardware - None Admin. - High, need many inspectors to be effective	Objections to interfering with travel	Some possible cheating	Many motorists will be stimulated to make prompt repair; can implement back to 1996 vehicles	Some motorists will take risk of not getting inspected and not repair vehicle
	Check when pulled over for other infraction	I	L	L	Hardware - None Admin. - Low/Moderate	Might appeal to lawmakers	Low possibility	Same as above	Same as above; police will likely not want to assume this duty

I = Can immediately enforce with ticket or can link to re-licensing vehicle
R = Link to re-licensing vehicle
H = Covers vehicles in entire country
(1) Might mitigate by delaying activation to allow a reasonable time for repair, make transponder short range, or put an off-switch on transponder (faster option would eliminate the advantage of instantaneous identification of high emitters).
(2) Since at times computers must be replaced, a device to identify a replacement is needed. Additionally, making tampering with software or hardware a federal crime would further deter computer hackers.
(3) Addition of permanent onboard memory could be used to provide an incentive for timely repair by voiding warranty and/or imposing penalties for untimely response to certain specific problems activating the MIL.
(4) Might mitigate by delaying activation to allow a reasonable time for repair; however, this option would still present liability issues.
(5) Possible concern about adverse impact on defrosting is thought to be unjustified, might mitigate by delaying activation to allow a reasonable time for repairs.
(6) A 10-20 % VOC/NOx reduction is possible according to the MOBILE model.

Appendix E
Interstate Comparison of I/M Results by Vehicle Model

The I/M Effectiveness-Information subgroup agreed that IM240 data from Arizona, Colorado, and Wisconsin would be compared to determine if I/M test results by vehicle model were similar among the three States. Models believed to be dominated by a single engine size and fuel system in a given model year were chosen (for example, all 1992 Ford Tempos were treated as a separate model from all 1992 Ford Topazes). Combined CO and HC failure rates for these models from the 1997 Wisconsin I/M program were circulated at the January meeting of the Incentives Workgroup. Failure rates for these models were then generated for the Colorado and Arizona programs, and sent to Workgroup members.

The most important element to consider when comparing I/M test results across programs are the cut points used. Arizona and Wisconsin used virtually the same cut points in 1997; however, Colorado used substantially looser cut points for HC and NOx (looser cut points result in lower failure rates, all else being equal). Another important distinction between the programs is the test cycle. All three States perform testing on a biennial basis. However, while Arizona tests all model years in each test year, Colorado and Wisconsin test only certain model years in a given test year. To complicate matters, in 1997, Colorado tested odd model year vehicles, while Wisconsin tested even model year vehicles. Finally, all three States allow clean vehicles to pass after as little as 31 seconds of testing; Arizona also allows dirty vehicles to fail after as little as 94 seconds. To compare average emissions across these programs, adjustments to approximate full IM240 emissions from the short tests must be made.

Figure E-1 shows the comparison of Arizona and Colorado initial IM240 failure rates by model (results of the comparisons with Wisconsin are similar). There is relatively good agreement in failure rate by model between the three I/M programs: for the most part, the same models have the highest failure rates in each of the three States. One reason for the good agreement is that models spanning eight model years are shown; since older cars fail at a higher rate than newer cars, older models tend to have higher failure rates than newer models. It was agreed that future analysis should include more models in a given model year, to see if the range in failure rates is consistent between States.

A more detailed analysis of emissions results from a larger number of models was performed on Arizona and Colorado data from 1996 (data from Wisconsin were not available at the time to perform this analysis). The models selected had relatively large sample sizes, with initial test results of at least 100 individual vehicles for each model. In this analysis, “model” encompasses vehicles with the same size engine displacement and fuel system, for a given manufacturer (for example, 2.3-liter Tempos and Topazes are both included as the 2.3-liter Ford model, and 3.0-liter Tempos and Topazes as the 3.0-liter Ford model). It is important to analyze failure rates for groups of vehicles that have similar technological characteristics. The grouping of vehicles in this manner requires decoding of the vehicle identification number (VIN).

Figure E-2 shows the comparison of initial IM240 CO failure rates for 60 1992 car models in Arizona and Colorado (only CO failure rates are shown, since Colorado's cut points for

HC and NOx are over two times those used in Arizona). Note that models tend to have higher CO failure rates in Colorado than in Arizona, even though the two States used the same cut points for these cars. There is good agreement in failure rates for most models; however, some models have dramatically higher failure rates in Colorado than in Arizona. Finally, because the vehicles are relatively new, about half of the models did not have any failing vehicles (a failure rate of zero). Many individual vehicles are necessary for some models, particularly for newer vehicles, in order to observe failure rates greater than zero.

Average emissions may be a better measure than failure rate to compare I/M test results by model. As Figure E-3 shows, within an I/M program, average initial IM240 emissions by model correlate very well with failure rate by model. Average emissions allows distinction between models with no failure rates, either because the cars are relatively clean or there are relatively few vehicles tested (or State cut points are extremely high or non-existent). In addition, standard error bars can be attached to average emissions values, to indicate whether differences between models are statistically significant. A limitation of using average emissions is that most vehicles are not given the full IM240 test; the results for most vehicles therefore need to be adjusted to represent full IM240 equivalent emissions. Figures E-4 through E-6 compare average initial IM240 emissions and standard errors by model between the two States for CO, HC and NOx. Models among the cleanest and dirtiest, as well as models that don't have consistent results in the two States, are labeled. Linear regression lines are also shown in the figures. The figures demonstrate the wide range in emissions by models of the same year, with the dirtiest models having average CO and NOx emissions over three times that of the cleanest models (the range appears to be even greater for HC). For the most part, average emissions by model in the two States agree well; however, there are some anomalies, such as the GM P (5.7 liter) engine, which has dramatically higher average emissions in Colorado than in Arizona. The data should be further analyzed to identify plausible causes of such anomalies.

Figure E-1. Combined CO and HC Initial Test Failure Rates, 1997 Arizona v. Colorado IM240, Selected Car Models

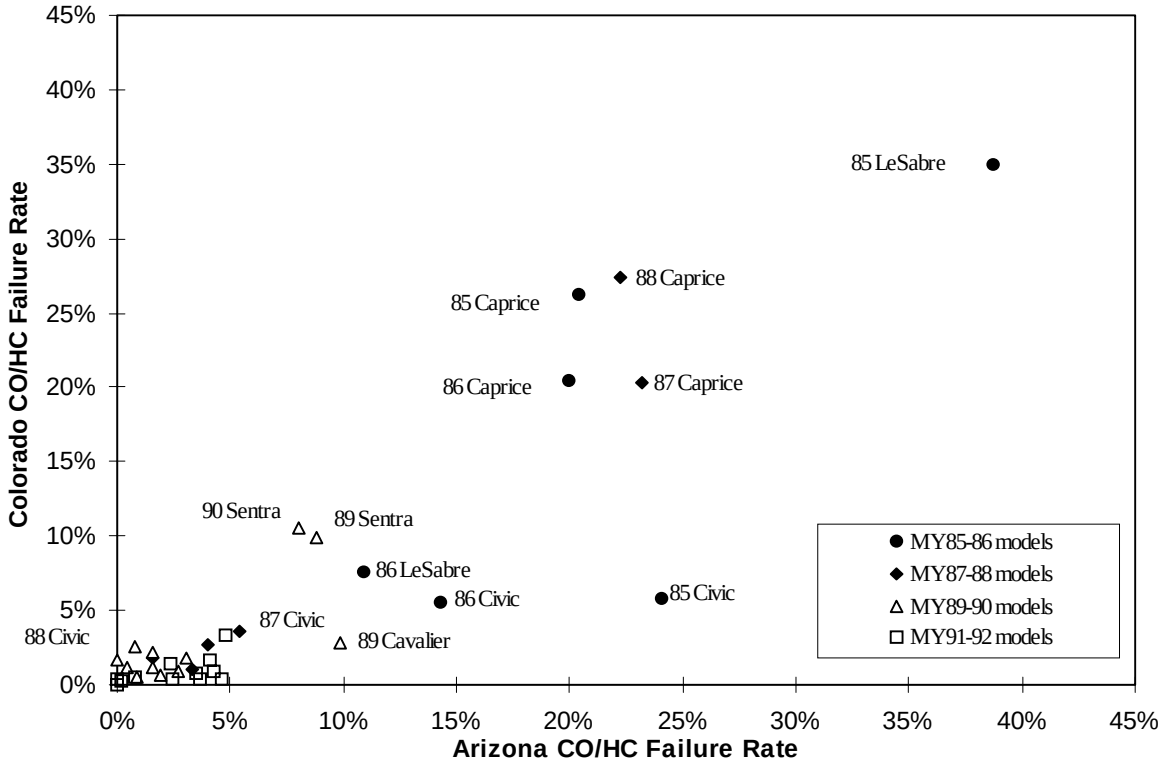


Figure E-2. Initial CO Failure Rate, 1996 Arizona v. Colorado IM240, 60 MY92 Car Models with at least 100 individual cars tested

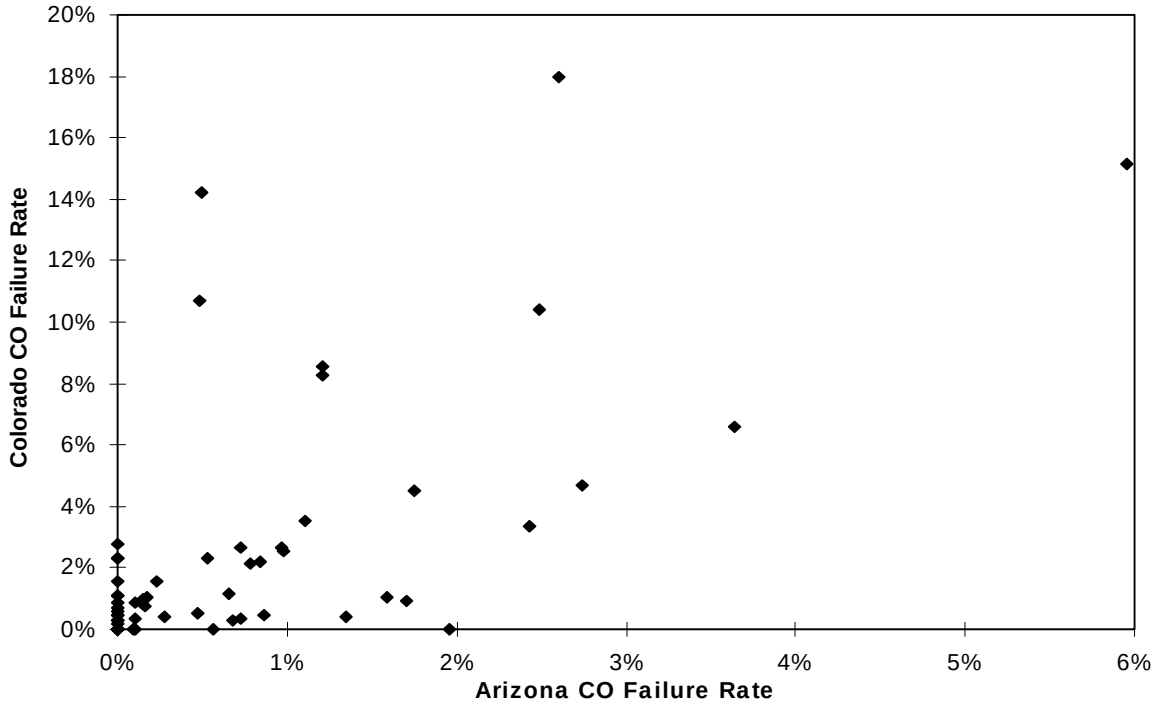


Figure E-3. Average CO v. CO Failure Rate, 1996 Colorado Initial IM240 Tests, MY92 Car Models with at least 100 individual cars tested

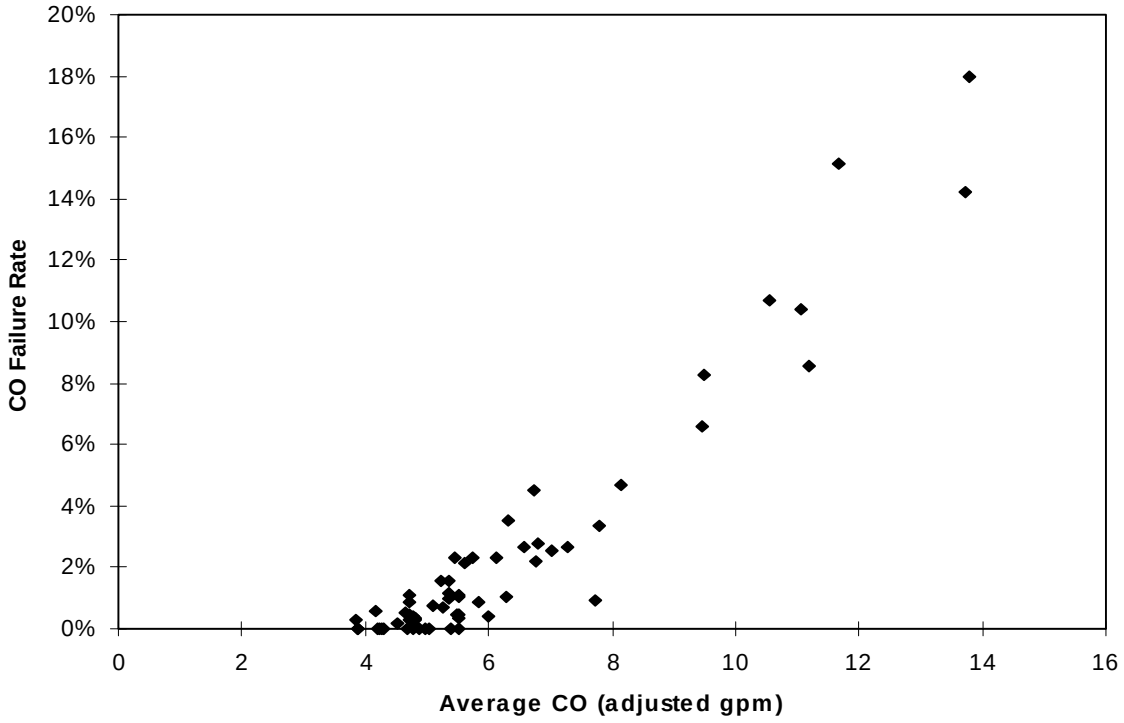


Figure E-4. Average CO gpm, 1996 Arizona v. Colorado Initial IM240 Tests, 60 MY92 Car Models with at least 100 individual cars tested

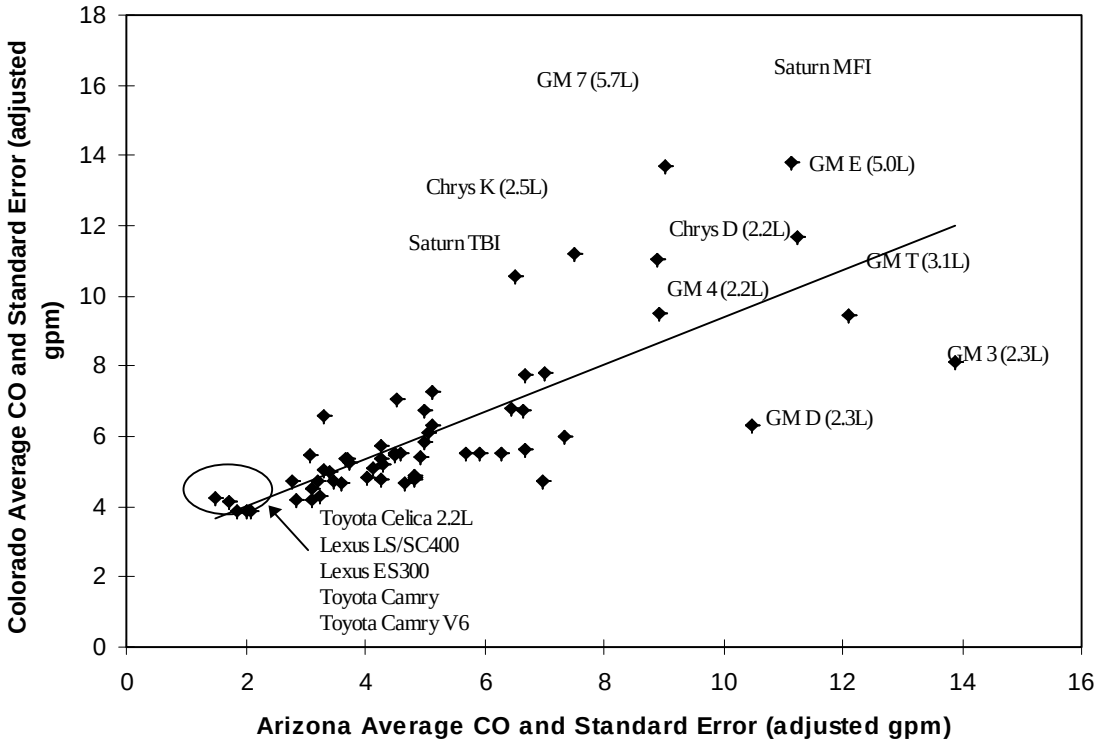


Figure E-5. Average HC gpm, 1996 Arizona v. Colorado IM240, 60 MY92 Car Models with at least 100 individual cars tested

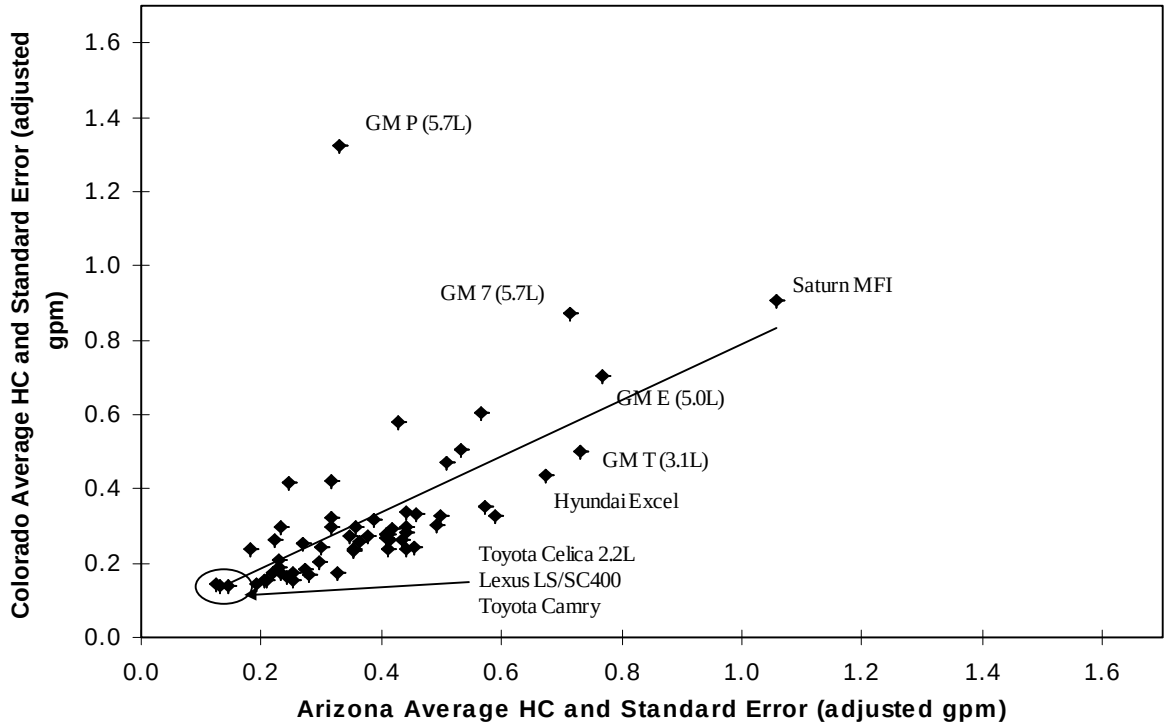


Figure E-6. Average NOx gpm, 1996 Arizona v. Colorado IM240, 60 MY92 Car Models with at least 100 individual cars tested